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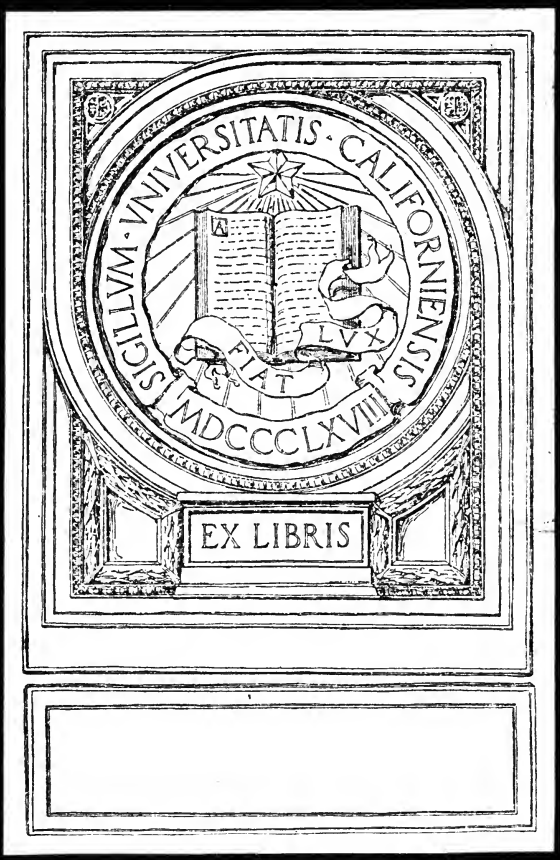
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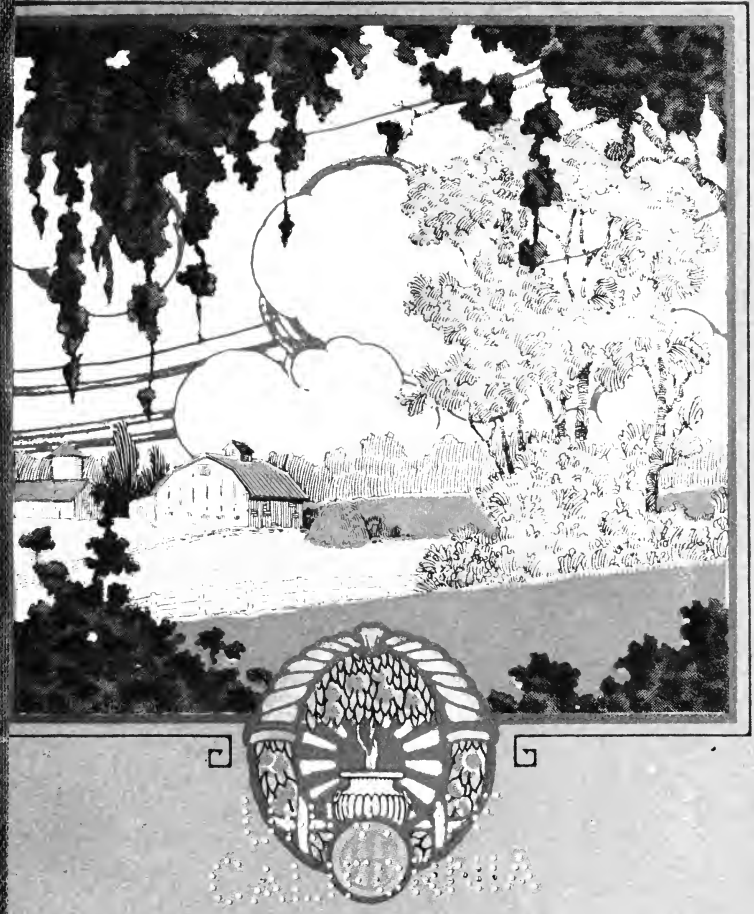

FOR BETTER CROPS IN THE SOUTH

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For Better Crops in the South

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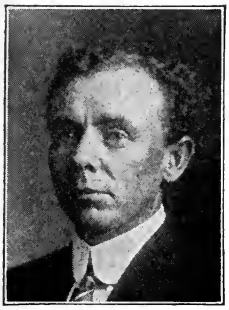
Corn Culture in the South

By J. Oscar Morgan, Ph. D.

Professor of Agronomy, Agricultural and Mechanical College of Texas, College Station, Texas



THE South's Corn Crop—The fact that the South produces annually nearly a billion bushels of corn, valued at more than a half-billion dollars, and this from an average yield of only twenty bushels per acre, makes plain the great future possibilities of this section as a corn-growing region. An increased yield per acre, rather than a greater acreage, is the most urgent need of Southern corn growers.

The Factors in Corn Production—The essential factors in successful corn production are good land well prepared, good seed, good care of the crop, and a favorable season. The two factors that are most responsible for the low yield of corn in the South are poor soil badly prepared, and poor seed. In this article only the soil and its preparation, together with cultural methods, will be discussed.

Soils Best Adapted to Corn—Few crops are grown on so great a variety of soils as corn. It is best adapted to well drained, alluvial, river-bottom soils. Swamp lands that have been well drained, and deep, upland soils containing rather large amounts of organic matter, are excellent for corn. Owing to its extensive leaf surface, corn transpires a large amount of water; hence the soil upon which it is grown must have a high water-holding capacity, thus enabling the plants to get water rapidly even during periods of drouth. Very compact clay soils or extremely loose sands are not suitable for corn.

Corn Best Grown in a Rotation—The continuous growth of corn on the same land is almost certain to result in a poor soil and consequently an unprofitable yield. With heavy applications of barnyard manure and commercial fertilizers it is possible to produce good yields for a long series of years, but this method is rather expensive, and greatly cuts down the profits. Few farms produce manure enough to practice such a system successfully. If fertilizers alone are depended upon to keep up the yields, the soil soon becomes deficient in organic matter, runs together and becomes compact, and an increasing amount

of fertilizer is required each year to maintain the yield. This has been the experience of thousands of Southern corn growers.

A Good Rotation—There is no one best rotation for corn. The system of farming to be practiced, as well as local conditions, are factors that must be considered in planning the rotation. The following rotation is applicable to most of the Southern states:

First year: Cotton with burr clover sown in fall for cover crop.

Second year: Corn, with cowpeas at last cultivation, followed by oats.

Third year: Oats, followed by cowpeas for hay.

The burr clover, following the cotton, can be sown at the last cultivation of the cotton. The seeds will remain in the soil until

Corn field in Dixie Land

late fall, when they will germinate and produce a winter and early spring cover crop to be plowed under for corn. Where it is desirable to plow the land in the fall, no cover crop should be sown in the cotton, but if possible it should be sown as soon as the land is plowed. The soil ought not to be left without a crop during the winter months, as this results in the loss of much plant food as a result of leaching. A winter crop is also very effective in preventing erosion.

The cowpeas sown at the last cultivation of the corn may be harvested for seed or pastured off. The cowpeas after oats are best harvested for hay. After this crop of hay is harvested, some winter-growing crop should be planted.

Fertilizers for Corn—Corn makes a rapid growth, producing a large amount of dry matter per acre. This necessitates the presence of rather large amounts of nitrogen in the soil. Phosphorus, though not taken up in as large amounts as nitrogen, is quite often the limiting factor in the growth of corn on southern soils, due to its general deficiency as a soil constituent. A

crop of corn producing fifty bushels per acre removes from every acre of land fifty pounds of nitrogen, eight pounds of phosphorus, and ten pounds of potassium, present in the grain; and twenty-four pounds of nitrogen, three pounds of phosphorus and twenty-six pounds of potassium, present in the stalks and leaves. This shows that the greater portions of both nitrogen and phosphoric acid are in the grain. The common practice on southern farms is to dispose of the grain in such a way that the fertilizing ele-

Cowpeas in the corn field indicates good farming

ments are not returned to the soil. The potash is present chiefly as a constituent of the stalks, and as the stalks are more often returned to the soil, together with the fact that most soils contain rather large amounts of potash, the addition of potash fertilizer to the corn crop is generally unnecessary. Nitrogen and phosphorus are the two elements of plant food that must be added to most southern soils, if corn is to be grown successfully.

Legumes and the Nitrogen Supply—Nitrogen costs the farmer approximately twenty cents a pound when purchased in

the form of commercial fertilizers. This makes it by far the most expensive element of plant food that must be added to the soil. There is above each acre of land approximately seventy-five million pounds of nitrogen, as a constituent of the air. If corn is grown in a crop rotation that includes some of the legumes, such as cowpeas, soy beans, clovers, vetches, etc., these legumes take up a portion of this free nitrogen and store it up in such a form that the corn can make use of it, thus dispensing with the necessity of buying this expensive element. A crop of cowpeas yielding at the rate of one and one-half tons of

A heavy growth of soy beans

dry matter per acre, if turned under will add to each acre of soil sixty-five pounds of nitrogen, or as much as is contained in a forty-five bushel crop of corn. If purchased, this amount of nitrogen will cost the farmer about thirteen dollars. Besides, the organic matter added by the cowpeas is worth more than the nitrogen.

Southern Soils Need Phosphorus—A very large proportion of southern soils are deficient in phosphorus, especially the soils of a sandy nature. It is not uncommon to find large areas of soils containing less than one hundred and fifty pounds of phosphorus per acre in the top six inches. Corn cannot be profitably grown on these soils without the addition of some material containing phosphorus. Acid phosphate is the material most commonly used.

Fertilizer Formulas for Corn—The character of the soil and its previous treatment will determine the amounts of the fertilizing materials to be added. As soils are extremely variable, no one fertilizer formula can be given that will fit all conditions. The following amounts per acre are suggested more as a guide to the farmer than an attempt to say definitely how much should be applied:

For clay and clay loams, in which no provision has been made for adding organic matter: 150 to 200 lbs. acid phosphate; 200 lbs. cotton-seed meal.

Or 150 to 200 lbs. acid phosphate, 75 to 100 lbs. nitrate of soda; the latter being drilled in six or eight inches from each row after the plants are two to three feet high.

For sandy lands: 150 to 200 lbs. acid phosphate, 200 lbs. cotton-seed meal, (or 100 lbs. nitrate of soda), 75 lbs. kainit.

If green crops have been grown and plowed into the land, or if medium to heavy applications of barnyard manure have been applied within one or two years preceding the growth of corn, the cotton-seed meal and nitrate of soda may be omitted.

When and How to Apply Fertilizers—All fertilizing materials should be applied to the corn crop a short time previous to or at the time of planting, with the exception of nitrate of soda. This latter material is readily soluble and easily lost from the soil, and consequently should not be applied until the plants are growing. A good practice is to apply a portion of the nitrogen at the time of planting, in the form of cotton-seed meal, and later supply the remainder of the nitrogen needed in the form of nitrate of soda.

The fertilizer is best applied by means of a fertilizer distributor, or by using a combined fertilizer distributor and planter. The latter can be very profitably used in applying those fertilizers that should be added at time of planting.

Fall versus Spring Plowing for Corn—There are many things to consider in comparing the relative merits of fall and spring plowing. If the farmer is willing to sow a cover crop on his land after it is plowed in the fall, and then re-plow it in order to turn this cover crop under in the late winter, there is no doubt but that he will find this a very profitable practice. This necessitates more work, but the increased yields will more than repay the farmer for this extra work. Soils of a sandy nature are not necessarily best plowed in the fall. A good plan is to disk or harrow them in the fall, and sow some cover crop, such as crimson clover, burr clover, vetch, or the small grains. The soil is then plowed in late winter and the cover

crop turned under, adding organic matter to the soil. In humid regions, soils without a cover crop leach badly, especially those of a sandy nature. Heavy clay soils are not so subject to leaching and are very profitably plowed in the fall.

Corn requires a deep soil, which means deep plowing. The one-horse plow has been too commonly used in preparing land for corn and as a result Southern soils, as a rule, are not deep enough. To deepen these soils will mean that considerable subsoil will have to be brought up and mixed with the top soil. This should be done in the fall, as subsoil brought to the surface in the spring will prove injurious.

Preparation of Land after Plowing—A large part of the tillage for corn should be done before the crop is planted. Harrows are not used enough in the South. The disk harrow, the spring-tooth harrow and the spike-tooth harrow are excellent implements for working the soil into a good seed bed after it is

A modern corn planter in operation

plowed. The best time to harrow the land is immediately after plowing, when the clods are moist and easily pulverized. Poor preparation before planting means a large expense in cultivating the crop, together with small yields. No amount of labor should be spared until a deep soil is prepared with a well pulverized seed bed on top.

Methods of Planting—Corn is planted in drills which are from four to five feet apart, depending on the productiveness of the soil. The richer the soil, the closer the drills can be, and the closer the plants in the row. On medium soil, capable of producing thirty-five or forty bushels of corn per acre, the rows should be from four to four and one-half feet apart, and the plants from fifteen to twenty inches in the drill. For silage, the plants should be much thicker in the drill.

The one-horse planter is most commonly used in planting the crop. On level land the two-horse, check-row planter can very profitably be used. Either the one-horse or two-horse planter should be used, as these implements save labor and afford a more even stand than the old method of dropping the corn by hand.

Depth of Planting—Corn should be planted deep enough to insure a generous supply of moisture for germination. On heavy clay, moist soils, planting to a depth of one inch is sufficient. On loose, sandy, relatively dry soils, planting to a depth of four inches is often necessary. The depth will vary between these depths, depending on the character of the soil. Planting late in the season usually necessitates deeper covering than early planting.

When to Plant—The date of planting corn in the South ranges from the latter part of February and first part of March,

A corn field on the I H C demonstration farm at Marion, Alabama

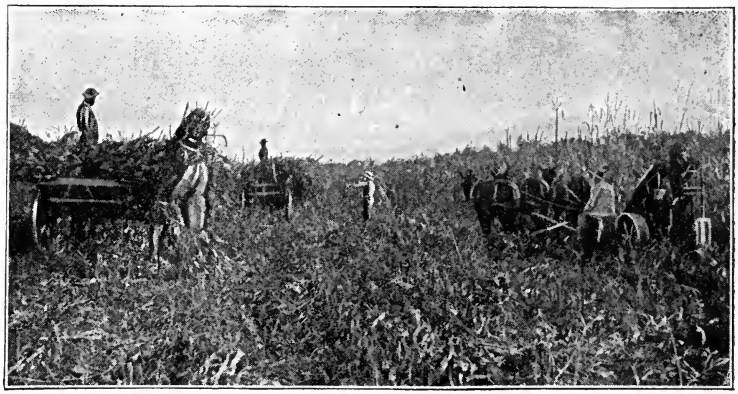
in the southernmost sections, to the latter part of April and first of May in the more northern sections. Corn should not be planted until all danger of a killing frost is past, and the soil is becoming warm. Uplands are usually planted earlier than lowlands; sandy lands earlier than clay lands.

Cultivating the Corn Crop—The feeding roots of corn grow comparatively near the surface of the soil, hence deep cultivation is very injurious. From one and one-half to two inches should be the usual depth of cultivation. There are conditions under which deeper cultivation would be justifiable, as, for example, when the corn is small and the soil hard and compact,

due to heavy rains. Deep plowing, as a rule, should be done when the land is first broken and shallow cultivation afterwards. Corn should be cultivated every ten days, during the rapid growing season.

The Use of the Harrow and Weeder—The harrow and weeder are very effective weed killers and their frequent use in the early stages of the corn's growth greatly reduces the cost of subsequent tillage. The harrow can, and should be, used from the time the corn is planted, until the crop is three or four inches high, and the weeder until the crop is six or eight inches high. This is the cheapest method of cultivating young corn, as ten to twelve acres can be gone over in a day.

One-Horse Cultivator—The greater portion of the South's corn crop is cultivated with one-horse implements. These, as



Harvesting corn

generally known, are small-pointed cultivators, sweeps, heel scrapers, and spring-tooth cultivators. These implements do very satisfactory work when properly used, but are not so economical of labor as the two-horse cultivators. If used when the corn is very small, they should have fenders attached to prevent covering the plants with soil.

Two-Horse Cultivator—This type of cultivator should be more commonly used in Southern corn culture than it is at present. Twice as much acreage can be cultivated in a day as with the one-horse cultivator, and the labor of one man is saved. With the present cost of farm labor, this means a considerable saving. There are two general types in use: the disk cultivators and those with shovels or small points. In using the disk cultivator, one must be careful to see that it does not cultivate too deeply, thus injuring the roots. If the corn gets so high as to be injured by the two-horse cultivator, which must straddle the

row, the last cultivation may be given with one of the one-horse types.

Harvesting the Corn Crop—The practices, so common in the South, of stripping the blades from the corn plants for "fodder," or of cutting the tops just above the ear, are too wasteful of time and grain to warrant their use. These operations are usually performed when a portion of the leaves have turned yellow, and the grain is beginning to become hard and dented. Carefully conducted experiments have demonstrated that when the corn crop is thus handled, at least three bushels of grain per acre are lost; besides, it is a slow operation.

The most profitable way to harvest the corn crop is to cut and shock the entire plant at the time the outer shucks have turned a straw color, and the grains have become hard. This does not reduce the yield of grain. When this method is followed, the crop can be harvested with the corn harvester, in sections where the land is comparatively level. This harvester cuts and binds the corn in bundles ready for the shock. If the land is of such a nature that the corn harvester cannot be used, a short-handled hoe or corn knife proves satisfactory.

Shredding Corn—A very profitable method of handling the corn crop, after it has been shocked and allowed to dry out thoroughly, is to shred it. The shredder is a machine that tears the stalks to pieces and husks and removes the ears at the same operation. In this condition the stalks are more profitably utilized than when they are fed whole. The stock eat a larger percentage of them, the stover is much more easily handled, and the manure produced is free from long cornstalks and is in a good mechanical condition. Another advantage is that the crop is gotten off of the land earlier, thus permitting the sowing of fall and winter crops.

Very often a number of farmers in a community will combine and buy a shredder, as the operation is one that does not have to be done at any particular time, thus enabling a farmer to wait his turn without any loss.

Increasing Fertility

ELEMENTS OF SOIL AND THEIR VALUE TO CROPS—FERTILIZERS AND SOIL BUILDING

By Cyril G. Hopkins
Professor of Agronomy, College of Agriculture, University of Illinois

IF he who made two bales of grass grow where only one grew before is a public benefactor, then he who reduces the fertility of the soil so that only one ear of corn grows where two have been grown before is a public curse.

Agriculture is the fundamental support of the American nation, and soil fertility is the absolute support of agriculture.

Without agriculture, America is nothing. The forest and the earth supply the timber, the stone, and the metal to build and equip railroad and factory, and the fuel to operate mill and locomotive, but directly or indirectly these great industries are absolutely dependent on agriculture for their continued existence.

The Two Functions of the Soil—The soil has two distinct functions to perform in crop production: First, the soil must furnish a home for the plant, where the roots can penetrate the earth upon which the plant must stand; second, the soil must furnish plant food, or nourishment, for the growth, development, and maturing of the plant.

To improve the physical condition of the soil is to improve the home of the plant; while to add to the soil, or to liberate from the soil fertilizing materials, is to increase the available supply of plant food.

One soil may furnish an excellent home for the plant, but a very insufficient supply of plant food; while another soil may contain abundance of plant food, but the physical conditions (such as imperfect drainage, or inadequate aeration) may be such as to make an unfit lodging place for the plant.

The Six Essential Factors in Crop Production—There are six essential and positive factors in crop production: (1) the seed, (2) the home or lodging place, (3) moisture, (4) heat, (5) light, and

(6) plant food. Some negative factors are injury from insects and plant diseases.

Good seed is exceedingly important, and the quality of the seed selected and planted is largely under the control of the farmer.

By proper drainage, by the use of organic matter, and by proper tillage, thus maintaining good physical conditions, the farmer may provide a suitable home for the plant, remove surplus water, render the soil more capable of absorbing and retaining necessary moisture, and control the temperature to some extent by lessening evaporation and by changing the color of the soil, as by the addition of organic matter.

More than five times as much heat is required to evaporate water from the surface of the soil as would be needed to raise the temperature of the same amount of water from the freezing to the boiling point. It is because of this that wet, poorly drained soils are cold. Dark soils absorb more heat and consequently are warmer than light colored soils.

Light is a factor over which man has no direct or positive control, but he has full control over some negative factors, such as weeds, which if allowed to grow might largely prevent the light from reaching the young plants. Indeed, the first and greatest damage caused by weeds is due to the fact that they shut off the light from the growing plants. If the supply of moisture or of plant food is insufficient for both the crop and the weeds, then the weeds may rob the growing crop of these essentials to some extent.

So-called nurse crops, such as oats or wheat when growing with clover, may grow so thick and rank as to injure to a marked extent the clover, by shutting out the light, also by robbing the clover plants of moisture and plant food. To avoid these injuries or difficulties, the clover should be started with a light seeding of wheat or oats (about one bushel to the acre) preferably planted in drills running north and south, which will permit the strong midday light to reach the clover plants.

If oats are seeded as the nurse crop, they should be an early maturing variety, or, they may be pastured off or cut early for oat hay. The surest method of obtaining a good setting of clover is to sow it without a nurse crop and pasture the field or clip the weeds with a mower if necessary.

The least understood and the most neglected essential factor in crop production is plant food. Food of required kinds and in sufficient quantity is as necessary for plants as for animals; and it is even more important to provide an ample and balanced ration for corn than for cattle, because cattle are usually able to move about and find some food for themselves, while the corn plants are stationary and limited to the food within reach of their roots.

The Ten Essential Plant Food Elements—There are ten different elements of plant food, each of which is absolutely essential to agricultural plants. These elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, iron, and sulphur.

Carbon, hydrogen, and oxygen, which constitute more than 90 per cent of most agricultural plants, are contained in air and water, the supply being unlimited. The two elements, iron and sulphur, although absolutely essential to plant growth, are required in very small amounts, while they are provided by nature in practically inexhaustible quantities.

On the other hand, the five elements, nitrogen, phosphorus, potassium, calcium, and magnesium, are required by plants in very considerable amounts, and soils are frequently found which are so deficient in one or more of these five elements as to limit

The old inefficient way of spreading manure

the yields of crops. It should be understood that soils are never found which are entirely devoid of these elements. Even the poorest and most unproductive soils still contain at least some small supply of each of these elements, and as a general rule such so-called exhausted soils contain at least one and frequently two or three of these valuable elements in large amount, the low productive capacity being due to the deficiency of one or two elements only.

Sometimes the element which the plant fails to obtain in sufficient quantity for its normal growth, the element which positively limits the yield of the crop, is actually present in the soil in a very large amount. In such cases the practice should not be to add to the soil more of this plant food element, but to adopt methods of soil treatment and management by which we can liberate a sufficient amount of this element for maximum profitable crop yields. This point will be further discussed in the pages following.

Nitrogen—The element nitrogen ought never to be bought in general livestock or grain farming. The atmospheric pressure is fifteen pounds to the square inch. Of this, about twelve pounds pressure is due to the nitrogen contained in the air. If we compute the value of this nitrogen at fifteen cents a pound, the price commonly paid for the nitrogen in commercial fertilizers, we find about $11,000,000 worth of nitrogen resting on every acre of the earth's surface.

It is true that such crops as corn, oats, wheat, timothy, cotton and tobacco have no power to make any direct use of this atmospheric nitrogen, but there is a class of plants known as legumes, including such valuable agricultural plants as red clover, alsike, alfalfa, crimson clover, cowpeas, soy beans, vetch, etc., upon the roots of which there are or should be small nodules or tubercles, varying from the size of pin heads upon clover roots

Manure exposed in this way loses its fertilizing elements very rapidly

to that of peas upon soy beans, in which live great numbers of very minute microscopic organisms called bacteria, which have power to take nitrogen from the air as it enters the pores of the soil, and to cause this free gaseous nitrogen to combine with other elements in suitable form for plant food which is then taken up by the clover or other legume for its own growth.

If the roots and stubble are left to decay in the ground, the nitrogen which they contain becomes available for succeeding crops of corn or other grains or grasses, but on land of moderate productive power the soil will furnish as much nitrogen to the clover crop as will be contained in the roots and stubble after the hay and seed crops are harvested. If the entire legume crop is plowed under as green manure, then all of the nitrogen taken from the air is left in the soil for succeeding crops.

If the crops are fed to animals provided with plenty of absorbent litter or bedding, as straw or refuse shredded corn fodder, so that all liquid excrement is saved, then about 75 per

cent of the nitrogen contained in the feed may be returned to the land in the farm manure.

In very intensive farming, as in market gardening near large cities, if the land is too valuable to be given up even for a part of a year to the growing of legumes for fertilizing purposes, then it becomes necessary to apply nitrogen; and this is also profitable, for the products of one acre frequently bring $100 or more for one season. In emergencies, commercial nitrogen, especially cotton-seed meal, may well be used for cotton, because of its high value per acre; but, as a rule, farm manure or legumes as green manures, could be substituted with greater profit in the long run.

Where it can be obtained, stable manure is usually the most economical and satisfactory form in which to apply nitrogen in market gardening, although cotton seed or cotton-seed meal, dried blood, tankage, sodium nitrate, and ammonia sulphate are also used with profit at times.

Phosphorus—If the element phosphorus becomes deficient in the soil, the total supply can be increased only by making an actual application of some kind of material containing phosphorus.

It is well to bear in mind that about three-fourths of the phosphorus required for ordinary grain crops is stored in the seed or grain, while only one-fourth remains in the straw or stalks. Consequently, when corn or wheat is sold from the farm, three-fourths of the phosphorus required to produce the crop leaves the farm in the grain.

When the crops are fed to growing animals or milch cows, about one-fourth of the phosphorus contained in the feed is retained in the bones, flesh, and milk, while about three-fourths is returned in the manure.

The total phosphorus content of the soil on any given farm may be increased by the purchase of stable manure, or by using manure made from purchased feeds, especially from grains or other concentrates, as bran, oil meal, or gluten feed; or we may purchase steamed bone meal from the stockyards companies who buy our cattle, slag phosphate from the steel works—if the slag contains sufficient phosphorus to make it valuable—or natural rock phosphate direct from the extensive natural phosphate deposits in Tennessee, South Carolina, or Florida, where this mineral is being mined and ground in large amounts. It may be noted that the original stock of phosporus naturally in the soil is powdered rock phosphate.

Potassium—Potassium, like phosphorus, is a mineral element contained in the soil, and if the supply in the soil is deficient it can be increased only by a direct application to the soil of some material. As a matter of fact, aside from peaty

swamp lands and some very sandy lands, the potassium contained in most soils is practically inexhaustible.

Of course the stalks, which are rich in potassium, should be returned to the soil, either directly or in manure. Even if they are burned (which should be the exception and not the rule) the potassium remains in the ash.

Peaty swamp soils are frequently exceedingly deficient in both available and total potassium as compared with normal soils, and, where the supply of farm manure is limited, commercial potassium salts may be applied to such land with very great profit. Potassium sulphate and potassium chloride (frequently, though incorrectly, called muriate of potash) are the most economical and satisfactory commercial potassium fertilizers.

Kainit is sometimes used, but it contains only 10 per cent of potassium while potassium sulphate usually contains 40 per cent, and potassium chloride contains about 42 per cent of the element potassium.

About 200 pounds of potassium sulphate or potassium chloride will supply sufficient potassium for a hundred-bushel crop of corn, and on very peaty land, where corn will not grow, such an application is recommended. The subsequent applications may be reduced in accordance with the amounts of potassium returned in the stalks and in the farm manure made from feeding the crop. But in dealing with soils of low productive capacity, of whatsoever class, it must be remembered that we must first grow large crops before we can make large amounts of manure, and if necessary we must always be ready to supplement our farm manure with any needed plant food if it can be obtained and used with profit.

Because soils deficient in potassium are usually abnormal and exist only in restricted areas, this class of soils will not be further considered except to mention in this connection that where such soils are found, as in some swamp regions, then the addition of potassium frequently produces most astonishing increases in crop yields. This is well illustrated by the results obtained on the University of Illinois soil experiment field near Momence, Illinois, in the Kankakee swamp area.

CROP YIELDS IN SOIL EXPERIMENTS
Peaty Swamp Land near Momence, Illinois

Plant Food Applied	1903 Corn Yield per Acre
None	7 bu.
Nitrogen	4 bu.
Phosphorus	5 bu.
Potassium	73 bu.
Nitrogen, phosphorus	4 bu.
Nitrogen, potassium	71 bu.
Phosphorus, potassium	73 bu.
Nitrogen, phosphorus, potassium	67 bu.

It will be seen that potassium increased the yield of corn by more than sixty bushels to the acre. It should be understood that some soils which are peaty in the surface with a heavier clayey subsoil within reach of the plow can be improved merely by deep plowing, for the clayey material is usually rich in potassium. It sometimes occurs that a subsoil exists which contains considerable amounts of total potassium, but this may become available slowly unless more actively decaying organic matter than peat is present. In such cases even light applications of fresh farm manure may produce an effect far exceeding that which is commonly expected.

Occasionally peaty swamp soils, like other soils, may contain some injurious alkali, as magnesium carbonate, in the sub-surface soil in such amounts as to prevent corn roots from living in it, and hence liberal amounts of available potassium provided in the surface soil may greatly benefit the crop. Deep peat and peat underlaid by clean sand are, as a rule, deficient in both available and total potassium.

It is well to remember that the seed or grain contains only about one-fourth of the potassium required for a crop, while three-fourths remains in the straw or stalks; also that animals retain practically none of the potassium consumed in the food, almost all of this element being returned in the solid and liquid manure.

Calcium—As an average, the normal soils of central United States contain only one-third as much calcium as potassium; while the average annual loss of calcium in drainage waters and in crops removed amounts to five or six times as much as the loss of potassium; so that in the maintenance of plant food the addition of calcium in limestone is of very much greater importance than is the application of potassium to the almost inexhaustible supply now present in such soils.

Magnesium—The amount of magnesium required by crops is appreciable, but not nearly so large as of the other four elements mentioned. Magnesium can be applied most cheaply and in readily available form by using dolomitic limestone. Dolomite contains about as much magnesium as calcium, and has slightly greater power to correct soil acidity than the ordinary high calcium limestone.

Making Plant Food Available—It is an absolute essential in agriculture to have plant food in the soil. If it is not present in abundance it should be supplied in the manner that is most economical and profitable, and that which is removed in crops should be replaced so far as practicable and profitable, either by returning it in farm manure, or by plowing under green manures, corn stalks, straw, and other coarse products, and by adding phosphate and limestone.

With a good supply of plant food stored in the soil, then the thing of greatest importance in the business of farming is the liberation of sufficient plant food during the growing season to meet the needs of maximum profitable crops. While thorough tillage aids in this process, by far the most effective and practical means within the farmers' own control for liberating plant food from the soil's supply or from insoluble material, as natural rock phosphate which may have been applied, is decaying vegetable matter.

The farmer or landowner whose farm practice includes these two points; that is, (1) plenty of plant food stored in the soil, or added to it when necessary, and (2) plenty of decaying organic matter to liberate plant food for the crop needs—will have in operation a system of agriculture which is permanent.

The one point is no more important or essential than the other. The man who tries to maintain the fertility of his soil and who hopes to continue to grow large, profitable grain crops without the use of legume crops or plowing under farm manures or coarse products, but who uses high-priced soluble manufactured commerical fertilizers, is unwise, and ultimately his land will probably follow the history of the lands which have been practically ruined by such practice in the eastern states.

On the other hand, the man, who thinks the productive capacity of the ordinary prairie land in the humid regions of Central United States can be permanently maintained merely by the use of clover in crop rotation, is also unwise, for this is absolutely impossible. So far as phosphorus and other minerals are concerned, the use of clover in crop rotation is one of our most effective means of liberating those plant food elements from the soil so that they may be removed in subsequent grain crops. Furthermore, clover and other legumes are themselves gross feeders on phosphorus, calcium, and potassium.

It is almost inexplicable that there are people who write and speak at great length and with great energy on the tremendous importance of adding nitrogen to the soil as an element of plant food, but who completely ignore and even deprecate the matter of maintaining in the soil a supply of phosphorus from which we can liberate sufficient amounts for large crops.

No man can afford to ignore the truth. If there are soils which contain so little phosphorus that we cannot by profitable means liberate sufficient to meet the requirements of large crops, then we should increase the supply; and every man should be sufficiently unprejudiced to ask frankly whether it is more sensible and more profitable positively to increase the total supply of any element of plant food in his soil, or to continue to decrease it by means of crop rotation and the use of decaying organic matter.

For the ordinary, strictly livestock farm from which only

hogs and cattle are sold, there is no such thing as reducing the supply of potassium if all liquid and solid manure is carefully saved and returned to the soil, because, as before stated, practically all of the potassium contained in the feed is returned in the manure. In dairy farming a small amount of potassium leaves the farm if milk is sold.

But even in livestock farming with all manure saved and returned to the land, we still lose the phosphorus carried away in bones, flesh, and milk, and this fact should not be ignored by the farmer whose crop yields are already limited because of insufficient supplies of phosphorus, even with abundant use of decaying organic matter supplied in clover and farm manure. Indeed, not infrequently we find farmers whose land is so rich in nitrogen and potassium that they grow great crops of straw and stalks, but the phosphorus is so limited that the actual yield of grain produced is only one-half or two-thirds what it should be.

A practice which is not followed by the best farmers

Let us remember that a balanced ration is just as important for corn as for cattle, and that phosphorus is required largely for the grain.

Soils Deficient in Nitrogen—It should be understood that the nitrogen in the soil is measured by the organic matter, for the nitrogen is practically all contained in the organic matter. Consequently soils which are deficient in organic matter are also deficient in nitrogen.

There are two classes of soils which are commonly much more deficient in nitrogen than in other plant foods. These are the very sandy soils and the very rolling or steeply sloping hill lands.

Improving Sandy Land—While the sandy lands are not rich in phosphorus and potassium, they are as a rule moderately well supplied with those elements, and such soils are so porous that they afford a very deep feeding range for the plant roots, so

that the actual percentage composition in mineral plant food does not fully measure the possible productive capacity of sandy soils as compared with more compact silt or clay soils.

As a general rule if the three elements, nitrogen, phosphorus, and potassium, be added separately to three different plots of very sandy land, the nitrogen will increase the yield, while little or no increase will be produced by either phosphorus or potassium. After plenty of nitrogen has been provided, then the addition of potassium will still further increase the yield. Actual results obtained on the University of Illinois soil experiment field on the sandy land, will serve to illustrate this:

CROP YIELDS IN SOIL EXPERIMENTS
Sandy Soil near Green Valley, Illinois

Soil Treatment Applied	1902 Corn Bushels	1903 Corn Bushels	1904 Oats Bushels	1905 Wheat Bushels	1906 Corn Bu.	1909 Corn Bu.
Nitrogen	69	65	44	24	63	59
Phosphorus	30	25	20	17	10	13
Potassium	23	20	17	17	8	13
Nitrogen, phosphorus	57	70	52	27	71	65
Nitrogen, potassium	70	73	55	37	75	74

It will be noted that where nitrogen was applied, the yield is more than double that obtained with either of the other elements. Except in 1902, phosphorus shows some effect when added to nitrogen, but potassium with nitrogen is more effective, especially in 1905, when it gave a yield of wheat thirteen bushels higher than was obtained with nitrogen alone. It should be stated, perhaps, that it is exceedingly difficult to select a number of exactly uniform plots for experimental use on this kind of soil and small differences may be attributed to soil variation, but the marked and uniform effects of nitrogen, and of nitrogen with potassium, are characteristic of such soil, and the further addition of phosphorus may sometimes prove profitable.

These results help to explain the marked effect of farm manure on sandy soils, especially when used for a crop rotation which includes legumes. Both the legumes and manure will furnish nitrogen, and the manure is also well supplied with potassium, the bedding being rich in potassium, and all potassium in the feed being returned in the manure. It may be noted that on very sandy lands clover does not grow well, but either cowpeas or soy beans is an excellent substitute for clover, as both do well on very sandy soil.

It is exceedingly important that so far as possible all crops shall be fed and the manure shall be carefully saved and returned to such land, not only for its plant food value, but also for the organic matter which is needed to improve the physical condition of the soil.

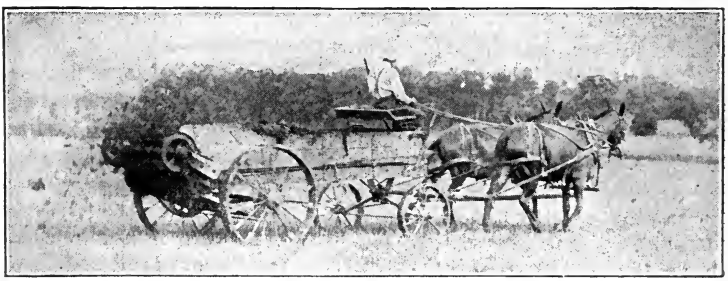
Improving Worn Hill Land—In actual field experiments on worn hill land on the University of Illinois soil experiment field, the following results have been obtained in a three-year rotation of wheat, corn, and cowpeas. By "legume" treatment is meant the growing of legume crops or catch crops, as cowpeas in the corn, or after the wheat, in the same season, which are turned under for the nitrogen and organic matter which they add to the soil.

CROP YIELDS IN SOIL EXPERIMENTS
Worn Hill Land near Vienna, Illinois

Soil Treatment Applied	1903 Yields	1904 Yields	1905 Yields
Wheat, Bushels per Acre			
None	0	7	1
Legume	1	1	11
Legume, limestone	1	10	18
Legume, limestone, phosphorus	8	15	26
Legume, limestone, phosphorus, potassium	11	18	30
Corn, Bushels per Acre			
None	9	31	38
Legume	5	36	43
Legume, limestone	8	49	62
Legume, limestone, phosphorus	7	49	57
Legume, limestone, phosphorus, potassium	11	45	57

The year 1903 was a very poor season for both corn and wheat. It will be seen that limestone and legumes (cowpeas or clover) have very great power to improve this class of soils.

As yet the addition of phosphorus and potassium has not



Saving labor and getting the best out of the manure

increased the corn yields, although with wheat, phosphorus has given a marked increase and potassium some further gain, notwithstanding the fact that these two best treated plot series were naturally slightly less productive than the other three

of the series. With more organic matter the effect of applied potassium will probably disappear.

Soils Deficient in Phosphorus—Phosphorus is the element of plant food most likely to be deficient in the common gently rolling prairie or upland timber soils of Central United States. Phosphorus is also commonly found to be one of the most deficient plant foods in long cultivated soils in eastern and southern United States.

The total amount of phosphorus contained in the surface seven inches of the commonest type of soil in the Illinois corn belt is no more than would be required for fifty crops of corn of 100 bushels each, or for about seventy such crops if the grain only were removed from the land. The next soil stratum is poorer in phosphorus than the surface soil and even a rich subsoil is of little value when buried beneath a worn-out surface.

The common so-called worn-out soil of southern Illinois contains but little more than half as much phosphorus as the corn belt soil. If clover failure is becoming more frequent than formerly, it is one of the strong evidences of insufficient phosphorus.

The results obtained on the typical slightly rolling prairie land of the central Illinois corn belt will serve to demonstrate that phosphorus is the element which limits crop yields on soils of this character, notwithstanding the fact that this soil is valued at not less than $150 an acre and is still producing very profitable crops even for land of that valuation.

CROP YIELDS IN SOIL EXPERIMENTS

Typical Corn Belt Prairie Soil near Bloomington, Illinois

Plant Food Applied	1903 Corn Bushels	1904 Oats Bushels	1905 Wheat Bushels
None	60	61	29
Nitrogen	60	70	31
Phosphorus	73	73	39
Potassium	56	63	33
Nitrogen, phosphorus	78	85	51
Nitrogen, potassium	59	66	30
Phosphorus, potassium	75	70	38
Nitrogen, phosphorus, potassium	81	91	52
Gain for phosphorus when added to nitrogen	18	15	20

It will be seen that the addition of nitrogen or potassium, separately or together, produces little benefit and sometimes the effect is a decrease in yield, although nitrogen did appreciably increase the yield of oats in 1904. After phosphorus has been applied, then nitrogen can be utilized with marked benefit.

Phosphorus produced a large increase in each crop even when applied alone, but when applied after nitrogen the increase was exceedingly marked, amounting to 18 bushels increase in corn, 15, in oats, and 20 bushels increase in the yield of wheat. While nitrogen was applied in commercial form (dried blood) in these experiments, these results emphasize the very great importance of using phosphorus in connection with clover and farm manure for improving this soil.

The use of commercial nitrogen was discontinued after 1905, but the addition of phosphorus produced 1.07 tons more clover in 1906, 19 bushels more corn in 1907, 12.2 bushels more corn in 1908, and 10.2 bushels more oats in 1909.

The possible effect of phosphorus on the clover crop itself may be seen in the results obtained in 1905 on the University of Illinois soil experiment field at Urbana, Illinois, which is also situated on good Illinois prairie soil. By "legume" treatment

Where both labor and fertility are wasted

is meant the growing of a catch crop of cowpeas or clover in the corn when it is "laid by."

CROP YIELDS IN SOIL EXPERIMENTS
Typical Corn Belt Prairie Soil, near Urbana, Illinois

Soil Plot No.	Three Years' Average Before Treatment Corn, Bushels		Soil Treatment Applied	1905 Clover Tons per Acre	
	60		None	1.26	
	64	Aver.	Legume	1.21	Aver.
	63	61.8	None	1.15	1.23
	61	Bu.	Legume, lime	1.32	Tons
	61		Lime	1.21	
	64		Legume, lime, phosphorus	2.91	
	62	Aver.	Lime, phosphorus	2.91	Aver.
	58	61.4	Legume, lime, phos., potass.	3.19	3.12
	61	Bu.	Lime, phos., potass.	3.19	Tons
	62		Lime, phos., potass.	3.41	

It will be seen that previous to the beginning of this soil treatment, the last five plots yielded no more than the first five; but after four years of soil treatment, the yield of clover was only 1.23 tons without phosphorus, while 3.12 tons of well field-cured clover hay were produced where phosphorus had been applied. The effect of potassium was slight.

Of course this increased crop of clover means a larger yield of corn to follow, and both clover and corn mean more farm manure for further soil improvement or maintenance.

As an average of the three years, 1907 to 1909, plots six and seven produced seventeen and one-half bushels more corn, seven bushels more oats, 1720 pounds more clover hay, and forty-three pounds more clover seed, per acre, than plots four and five; these increases being due to the application of phosphorus. In the later years the use of limestone is also producing profitable increases on the older prairie lands of the corn belt.

Soils Deficient in Both Phosphorus and Lime — Soils on which clover can not be grown successfully even before they are badly worn are usually acid and consequently deficient in limestone, but as a matter of fact such soils are usually deficient in both limestone and phosphorus.

The effect of limestone and of limestone and phosphorus in connection with legume treatment on the University of Illinois soil experiment field, will serve to demonstrate the need of both limestone and phosphorus on such soils as are commonly called "clay land," which refuses to grow clover.

WHEAT YIELDS IN SOIL EXPERIMENTS

Typical Wheat Belt Prairie Soil in "Egypt," near Odin, Illinois

Soil Treatment Applied	Yield per Acre Average fo Eight Years
None	11 bu.
Legume	12 bu.
Legume, limestone	17 bu.
Legume, limestone, phosphorus	26 bu.
Legume, limsetone, phosphorus, potassium	28 bu.
Gain for legume, limestone, phosphorus treatment	15 bu.

On similar soil in Wayne county in southern Illinois, an experiment field was started on forty acres of land in 1905. A four-year rotation of wheat, clover, corn, and cowpeas (or soy beans) is practiced on four ten-acre fields, so that each crop may be represented every year. Two tons of ground limestone and one ton of fine ground raw rock phosphate, per acre, are applied

once in four years on part of each field, while no limestone or phosphate are applied to the remainder, which is cropped and treated alike in all other respects. At $1.25 per ton for the limestone and $7.50 per ton for the phosphate, the cost of these materials amounts to $10.00 per acre once in four years; whereas, in 1910 the land treated with limestone and phosphate produced 17 bushels more wheat, 2½ tons more clover (in two cuttings), 19 bushels more corn, and nearly 8 bushels more soy beans, per acre, than the land not so treated. Here is very satisfactory profit and positive soil enrichment. Still greater benefit is expected in the future, because hereafter the manure applied, or the clover and crop residues to be plowed under, will be in proportion to the crop yields of the previous rotation.

The treatment recommended for these soils, which are well represented by the extensive worn "clay lands" in Ohio, Indiana, southern Illinois ("Egypt"), and Missouri, is as follows:

Apply 1,000 to 2,000 pounds to the acre of finely ground natural rock phosphate with as much organic matter as possible (manure, legume crops, etc.,) and plow under, then apply two or three tons to the acre of ground natural limestone and mix with the surface soil in preparing the seed bed, and then grow a good rotation of crops, such as wheat, clover, corn, and cowpeas; or wheat, clover, wheat, clover, corn and cowpeas; or corn, cowpeas, wheat, meadow and pasture (clover and timothy being seeded with the wheat crop for two or three years' meadow and pasture). At the end of the rotation another heavy application of rock phosphate in connection with all available farm manure, should be made, preferably to the pasture ground and plowed under for corn.

If necessary, limestone must be added occasionally to keep the soil sweet. About two tons per acre every rotation will be sufficient. (Blue litmus paper, which can be obtained from a drug store, if placed in contact with the moist soil for 20 minutes will be turned red if the soil is sour).

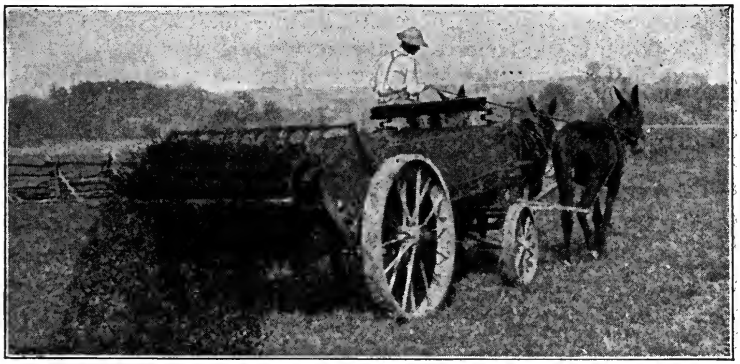
The Value of Farm Manure — Farm manure always has been and probably always will be one of the most important and abundant materials for soil improvement. It is a necessary product on every farm and on stock farms a product which accumulates in very large amounts. If not used for soil improvement, it becomes a worthless nuisance about the stables, whether in the city or in the country.

A conservative estimate places the annual production of farm manure in the United States at a billion tons. The actual agricultural value of fresh farm manure containing both the liquid and solid excrements is not less than $2 a ton, whether the value is measured in terms of plant food elements actually contained in the manure as determined by chemical analysis of

the manure and the market values of the elements, or whether the value is measured by the actual increase in crop yields produced by the use of the manure on ordinary long cultivated soils.

Waste of Farm Manure and Land Ruin—If fresh farm manure is thrown out and exposed to the weather for six months in summer, one-half of its total weight of dry matter is lost, and more than one-half of its value as a fertilizer is lost. In most newer countries there is enormous and shameful if not wicked waste of farm manure. In older countries it is the rule to save all possible farm manure with very great care, although this rule is too frequently broken by the careless, ignorant, or short-sighted.

As a whole, the unnecessary waste and loss of farm manure which occurs in the United States each year is equal in value to



A uniform application of manure insures better returns

several times the value of all commercial fertilizers used in this country. Sometimes the waste of farm manure and the purchase of commercial fertilizers occur upon the same farm. In such cases the commercial fertilizer used is usually a so-called "complete" fertilizer, containing acid phosphate with a trace of nitrogen and potassium too small to add appreciably to its value, and it is commonly applied in amounts which supply less plant food than the crops actually remove, the small amount of soluble plant food applied being supplemented by that which the soil would naturally give up, together with what can be forced from the soil by the stimulating action of the soluble corrosive acid salts and manufactured land-plaster contained in such fertilizers.

One of the most common commercial fertilizers used in the United States contains the equivalent of two per cent of ammonia, eight per cent of falsely so-called "phosphoric acid," and two per cent of potash, corresponding to less than four pounds of nitrogen, seven pounds of phosphorus, and less than four

pounds of potassium in 200 pounds, the most common application per acre; whereas a 100-bushel crop of corn removes from the soil not four, but 150 pounds of nitrogen, not seven but twenty-three pounds of phosphorus, and not four but seventy-five pounds of potassium.

Saving Farm Manure—In order to retain the full amount and full value of farm manure, it should be removed directly from the stall or covered feed lot and spread at once upon the land. Where the winters are moderately cold and free from heavy rains there is little loss if the manure is allowed to accumulate during such weather in a small, uncovered feed lot, provided it is hauled out and spread upon the land in the early spring. Manure may be allowed to accumulate without much loss in deep stalls for several weeks if plenty of absorbent bedding is used, and then it may be hauled from the stall directly to the field and spread.

It should be the rule never to handle manure more than once. When taken from the stable or feeding shed it should be at once loaded onto the spreader and hauled to the field. If manure is produced at the rate of two loads or more a week, the convenience and importance of taking this manure directly from the stable and spreading it at once upon the field will certainly justify providing a manure spreader or special wagon to be used solely for this purpose.

Increasing the Value of Farm Manure—While ordinary fresh farm manure is worth $2 a ton for use on ordinary soils, its value can easily be increased to $3 a ton net, by replacing in liberal amounts of low-priced, very finely ground, natural rock phosphate, the element phosphorus, which the animals have extracted from the feed and used in making bone, thus leaving the manure poor in phosphorus as compared with the crops grown and fed.

It should be remembered that practically all potassium contained in the feed is returned in the liquid and solid excrements and that the nitrogen, which is in part retained by the animal and in part returned in the manure, can be fully maintained by supplementing the farm manure with clover grown in the crop rotations and plowed under.

By far the most complete and valuable work ever reported upon the subject of increasing the value of farm manure by the addition of natural rock phosphate has been done by the Ohio agricultural experiment station under the direction of Professor Charles E. Thorne in an extensive and most trustworthy series of experiments extending over a period of thirteen years.

As a rule for use on land which is deficient in phosphorus, rock phosphate should be mixed with average manure in such proportions that at least 250 pounds of rock phosphate per acre

would be provided for each year. Thus for a four-year rotation, including corn for two years, oats for the third year and clover for the fourth year, about 1,000 pounds of rock phosphate an acre should be applied to the clover ground in connection with all available farm manure and plowed under for corn. If the land is manured once in four years with ten loads of manure to the acre, then 100 pounds of rock phosphate should be applied with each load.

A very simple and satisfactory method of applying rock phosphate to the land, which involves practically no extra labor or loss of time, is to load the manure spreader part full of manure, then scatter one hundred pounds of rock phosphate over it as

Manure spread evenly is most valuable

uniformly as possible, finish loading, and drive to the field and spread the phosphated manure. This brings about a very complete and intimate mixture of the manure and rock phosphate, and this is exceedingly important, because the decaying organic matter must be in intimate contact with the rock phosphate in order to liberate the phosphorus for the use of the crops. Where manure is not available, more clover should be plowed under.

A System of Permanent Agriculture—This practice of applying liberal amounts of natural rock phosphate in connection with sufficient clover, or with all of the farm manure which can be made on the farm from the hay, straw, and other coarse products and from the oats or other low-priced grains, together with the use of a good rotation, including plenty of clover, provides for an absolutely permanent system of agriculture, even

though high-priced grains and animal products are sold from the farm. It is a system under which the land grows richer and richer and more and more productive and valuable, instead of becoming poorer and less productive, as has been the case with by far the larger part of the older cultivated lands in the United States.

For more complete data, simple discussion, and plain explanation of the most essential information the world affords, relating to soils and methods of soil improvement, the reader is referred to a book on "Soil Fertility and Permanent Agriculture," published by Ginn & Company, of Boston, Massachusetts.

How to Grow Cotton in Spite of the Boll Weevil

By G. H. ALFORD*
I H C Agricultural Extension Department, Atlanta, Georgia.

Destroy the boll weevil. Force the cotton plants to early maturity.

Reduce the number of weevils by destroying the food supply; by burning all rubbish in and about the cotton fields which are serving as hibernating quarters; by picking off the old weevils when they appear on the cotton plants early in the spring; by gathering the punctured squares and destroying them for the first month after the cotton season opens.

Force the cotton plants to early maturity by selecting an early maturing variety; by fertilizing properly; by carefully selecting early maturing seed, and by thorough cultivation.

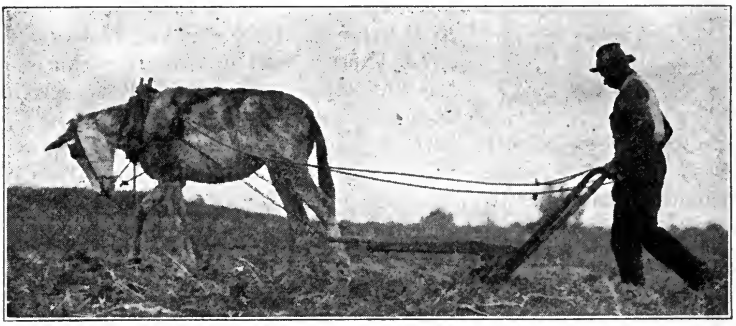
Destroy Food Supply—The most important step in producing cotton in boll weevil territory is the early fall destruction of the weevil's only food supply, the squares, small bolls, and foliage on the cotton stalks. When their food supply is destroyed early in the fall, they will either starve for lack of food before cold drives them into quarters or will go into winter quarters "lank and lean" and very few will survive for spring depredations. Another very important reason for the early fall destruction of the squares and small bolls on the cotton stalks is that the development of the late broods of young, fat, vigorous weevils that survive the winter is cut off at once. There are three methods of destroying the squares, small bolls and foliage on the cotton stalks: Pasturing, plowing under, burning.

Pasturing Cotton Fields is a good method of destroying the squares, small bolls, and foliage—the food supply of the mature

*EDITOR'S NOTE: Mr. Alford, who now has charge of the I H C Agricultural Extension work in the South, served several years in the employment of the Government at Washington, D. C. As a legislator in Mississippi, his principal work was promoting legislation in behalf of the agricultural interests of the state. He has made a thorough and extended study of the cotton boll weevil and is regarded as one of the best informed men on this subject in the South. He has spent considerable time in the midst of the boll weevil fight in southern Mississippi, where he had charge of the Government demonstration work.

weevils and the incubators of the immature weevils—where the cotton fields are fenced and the number of cattle turned into the field is sufficient to eat all the squares, small bolls and leaves in a few days. However, let it be distinctly understood that the practice of turning a few head of cattle into a field of fifteen or twenty acres of cotton stalks accomplishes no particular good. We all know from observation that two or three head of cattle per acre, even when confined in the cotton field, will eat very little of the green foliage in ten days. And let us not forget that it is necessary to destroy completely the food supply of the mature weevils and to stop the development of broods at the earliest possible stage.

Plowing Under the Cotton Stalks is a good method of destroying the only food supply of the mature weevils and of ending the life of the immature weevils where there are few stumps, small cotton stalks, and where large plows and strong



A serious drawback to Southern agriculture

teams can be had. I have held the plow handles in the piney woods, in the prairie section, and in the rich bottom lands, and I know from experience that it is very difficult to bury completely the average size cotton stalks. I have hitched three large mules to a twelve-inch steel beam turning plow with a log chain attachment and failed to turn completely under average size cotton stalks on land clear of stumps. I have failed to turn under large size cotton stalks with four large mules hitched to a thirty-inch disk plow. In fact, farmers who have attempted to plow under green cotton stalks early in the fall laugh at the advice sometimes given to plow under the stalks at all times and under all conditions as a means of destroying the food supply of the weevils. However, let us use large plows and strong teams and completely bury the stalks wherever it can be done.

Burning the Cotton Stalks as soon as the cotton is picked out it is absolutely necessary on farms and plantations where there is an insufficient number of cattle to denude the cotton

stalks of squares, small bolls, and green foliage, thoroughly and completely in a short time, or where it is impossible to bury the cotton stalks completely. When the stalks are burned, the food supply of the adult weevils is destroyed and the large majority of the adult weevils perish in the flames when the stalks are burned after sundown. Of course, if it is impossible to pick the cotton out and the stalks are allowed to remain until a heavy frost has come and the weevils have gone into winter quarters, it is not advisable to burn the stalks.

Destroy Hibernating Places—Practically all of the weevils hibernating in corn fields, old sorghum or cane fields, along turnrows, fences, hedges, ditches, and in the vicinity of the cotton fields can be destroyed. If the cornstalks, sorghum and cane shucks are thoroughly plowed under for a depth of several inches, very few weevils survive. The clearing of the stumps and dead trees in and around the cotton fields and the cleaning

The way to plow if results are expected

and burning of hedges, ditch banks, fence corners and other hibernating places in the fields and in the vicinity of the fields will destroy thousands of weevils.

Pick the Weevils—When the weevils first appear in the spring, they eat the tender leaflets of the terminal buds of the young cotton plants. After the squares begin to form, they feed upon them and seldom puncture bolls as long as squares are abundant. It is advisable to pick the weevils off the little cotton until numerous squares begin to form. One pair of weevils less in the spring means millions less later in the season. Children under ten are unable to do farm work and may pick the weevils off the little cotton. Do not lay down the hoe and stop the plow to pick off the weevils.

Gather the Punctured Squares—The beneficial results obtained from picking up fallen punctured squares depends mainly upon the season. When the punctured squares fall to

the ground and are subjected to the unobstructed rays of the sun, the mortality of the larvae and pupae is exceedingly high. When the rows are wide and the cotton small, practically all the larvae and pupae in the punctured squares are killed during hot, fair weather. If the rows are narrow and the cotton makes a rank growth and shades the ground, or if it is cloudy, practically all of the larvae and pupae in the punctured squares will come to maturity unless the squares are picked up and destroyed. The more rankly the cotton grows and the more the ground is shaded, the greater the necessity for picking up and destroying the punctured squares. It is well to collect all the squares that fall for at least a month after the first square forms and place them in wire cages or burn them. The punctured squares ought

The tractor at work in the field

to be placed in wire cages for the reason that many weevil larvae in the infested squares harbor parasites. The meshes of the wire of the cage should be at least sixteen to the inch. The parasites on account of their small size will escape, and continue their deadly work against the weevils in fields while the weevils will soon die for lack of food. A tinner will make the cages at a reasonable price. Of course if it is not possible to use the wire cages, burn the squares.

Grow an Early Maturing Crop—The production of an early crop of cotton is accomplished as follows: Cut the cotton acreage to five or six acres to the mule so that cultural methods may be closely followed. Plant only warm, quick-making land

Cultivating young cotton

to cotton. You may plant bottom land, hill land, rich land or poor land, but the land must be quick-making land. Late land will not make cotton in the weevil territory. Where the soil responds to commercial fertilizers, apply from three to eight hundred pounds per acre to hasten maturity and increase the yield. Thoroughly pulverize the soil before planting. Work the soil until it is like an ash heap for three or four inches deep. Plant early, rapid-fruiting, prolific cotton seed. Plant as early as the season will permit in rows a little wider than the cotton usually grows tall.

Commence to work the cotton as soon as possible and never permit a crust to form or the field to become grassy. Continue till the cotton begins to open.

Fertilizers—On rich lands use mainly fertilizers that stimulate the fruit and not the stalk growth. High grade sixteen per cent acid phosphate is the basis for increasing fruit and hastening maturity. Cotton-seed meal is the basis for stimulating stalk growth. A mixture of two parts of sixteen per cent acid phosphate and one part of six per cent cotton-seed meal is a good mixture for poor land. It is best to lay off the rows, distribute the fertilizers in the furrows and bed on it.

Selection of Seed—The production of an early crop of cotton is now absolutely necessary. We must either buy early, rapid-fruiting, prolific cotton seed or select seed from cotton plants with low fruit limbs and short joints on the main stem and fruit limbs. The results obtained by experiment stations have proven conclusively that we may develop early, rapid-fruiting strains of cotton by selecting seed from early, rapid-fruiting, prolific cotton plants. The results obtained show that one selection increases the earliness and productiveness to a surprising extent.

Cultivation—This should begin before the cotton comes up. It is best done by running two sections of a peg-tooth steel harrow across the rows. The loosening of the surface soil with peg-tooth steel harrow helps to let the young plants through, and kills millions of tiny weeds and grass plants just as they are coming up. The cotton should also be harrowed broadcast with the peg-tooth harrow after it comes up. This early cultivation with the harrow kills the little grass and weeds in the sprout and does away with the necessity of "barring off," forms a soil mulch all over the field which holds the moisture in the ground, and causes the young plants to grow rapidly. Broadcast harrowing with a two-horse team is quickly done and is the best kind of cultivation until the cotton is large enough to be thinned and worked with a disk harrow, heel sweeps and walking and riding cultivators without covering it. The use of the harrow before

and after the plants come up also reduces the necessity for the use of the expensive hoe to the minimum.

All later cultivation should be made with such implements as disk harrows, and two-horse cultivators and heel sweeps. A turning plow is out of place in a cotton crop unless the soil is devoid of vegetable matter and runs together after heavy rains or unless it rains for two or three weeks and it becomes necessary to bury grass. If the land is clear of roots and stumps we can give a large angle to the disks on a disk harrow, straddle the row and throw dirt toward or away from the cotton plants. One man with two horses and a disk harrow can take a row at one time and destroy the grass and weeds and make a fine soil mulch out of the hardest, sun-baked soil.

The latest reversible disk harrow is furnished with an extension which raises the harrow frame high enough so that cotton grown on soil of average fertility can be entirely cultivated with

The disk harrow preparing a cotton seed bed

this implement. However, when it is absolutely necessary to use the turning plow by all means avoid deep cultivation late in the season, and be sure and use harrows or cultivators a few days after using the turning plow to make the stirred soil thoroughly fine and create a dust mulch.

Cultivation with turning plows and one-horse cultivators is too slow for the boll weevil territory and should not be practiced unless the land is full of roots and stumps. Such a condition is inexcusable for the reason that we can burn, dig, pull and blow out the stumps in a few years. Spare time can be used to the best advantage in getting out stumps and roots. This is an age of labor-saving farm implements and no farmer can afford to walk down each middle three or four times in cultivating his crop. The boll weevil is one of the most energetic and destructive insects that the world has ever known, and usually completely destroys the slow farmers' crop.

Where cotton is King

The Race Begins— A majority of the wintered-over weevils are out of winter quarters by the time the cotton begins to set squares. A race that means much and a race that is watched by all the world then begins. The cotton runs the race of its life to set squares faster than the weevils can multiply and puncture them. If the land is warm, quick-making, thoroughly pulverized and fertilized with from three to eight hundred

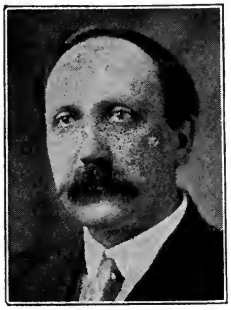
A disk harrow cultivating cotton

pounds per acre, the seed an early, rapid-fruiting, prolific variety, the crop given intensive, shallow cultivation until the cotton begins to open—the cotton goes out under the wire far in the lead with from one-half to a bale per acre. If the land is "late" broken into clods, very little fertilizer applied, the seed a late, slow-making variety, the cultivation slow and deep, the weevils will soon destroy all the squares, and then destroy all the bolls.

Small Grains in the South

By Prof. M. A. Carleton

Bureau of Plant Industry, U. S. Department of Agriculture



The actual farm value of the small-grain crops in the South is probably greater than is generally supposed. The value of either oats or wheat, is not far from that of the corn crop. Even if no profit is obtained from the sale of a surplus it is a great convenience for the farmer to grow the quantity of small grain necessary for his own use. Besides, small grains fit well in several good systems of crop rotation, and rotation is practically necessary to increase the chances of getting returns each year and to maintain a well-balanced supply of plant food in the soil.

The Small Grain Sections—The principal small-grain crops are oats and wheat, and for convenience of discussion in this paper the entire region may be roughly divided into two portions, (1) the northern or wheat area, including the Carolinas, eastern Virginia, and Tennessee, and (2) the southern or oats area, called also the Cotton Belt, including the remainder of the territory southward to the Gulf, the northern part of Florida, and westward to include most of Arkansas and eastern Texas. Tennessee at present produces the largest quantity of wheat, although South Carolina has increased her wheat acreage proportionately much beyond that of any other Southern state. Georgia is the most important state in oat production.

OATS—The three groups of varieties that are commonly grown in the South include (1) the Red Rustproof strains, (2) the Burt oat, and (3) the Turf or Gray Winter strains. The Red Rustproof group includes red chaff varieties, bearded, and with a bunch of bristles at the base of the lower grain of the spikelet. The chief variety is known simply as Red Rustproof. The Appler oat, however, belongs to the same group. These varieties are in adaptation a mean between spring and winter oats, so that while grown in the Northern states as spring varieties they are commonly sown in the fall in the Cotton Belt states and therefore classed there as winter oats.

The Burt oat, called also Early Burt, has a grayish or dun-colored hull, is distinguished by early ripening, and is much

shorter in growth than the Red Rustproof. It is strictly a spring variety and is particularly adapted to the northern area of the Southern states.

The Gray Winter or Winter Turf varieties have also a gray or light dun-colored chaff, but are quite different from the Burt in being true winter varieties and are also much hardier for fall sowing than the Red Rustproof type. They are, therefore, particularly adapted for fall seeding in the northern area, but are also grown in the southern district.

Soil—The oat crop is rather exacting on the soil, but at the same time can be grown with good results on poorer soil than most other cereals. However, like all other cereals it requires

An oat field where cotton once grew

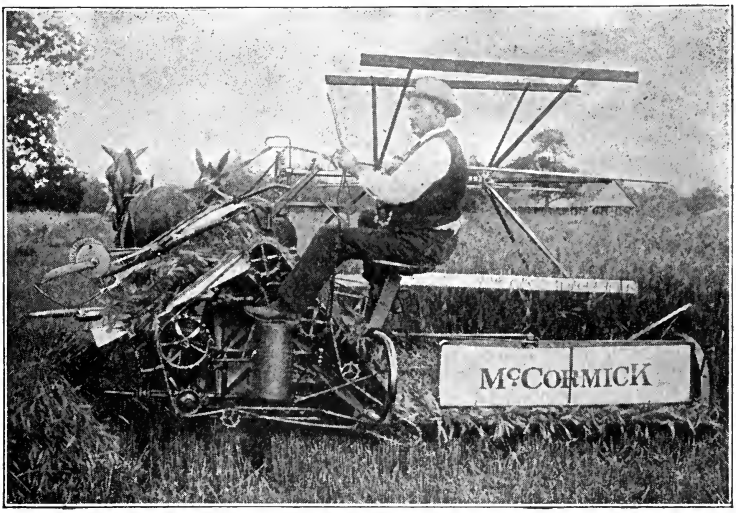
for the best results some kind of clay loam with as much organic matter as ordinarily occurs in any Southern soil.

Oats in Rotation—A good rotation for oats is to place them after corn, the oats followed by cowpeas the same season, and these followed by cotton the third year, then corn again. In this series, it is common also to plant cowpeas with the corn. There is, therefore, the beneficial effect upon the soil of two leguminous crops in succession. Even in the Cotton Belt the oats following corn is a good plan, for the reason that the latter comes off in time for the fall seeding of oats. When oats are sown in the spring, of course, they could just as well follow a cotton crop.

In the district comprising Alabama, Mississippi, the western portion of Tennessee, Louisiana, and southern Arkansas, lespedeza, or Japan clover, has come to be a very important crop, and

a very good rotation with this crop can be arranged in which oats occur. One rotation is that of corn, oats, and lespedeza. Corn is harvested the first year, oats and lespedeza sown together the second year, and the lespedeza alone the third year, the latter re-seeding itself the last season. In this district lespedeza appears to be an excellent hay crop.

Fertilizers—Unless an abundance of stable manure is available or leguminous crops are grown in rotation, the small grains will always require artificial fertilizers. Even in the best cropping systems, these fertilizers may occasionally need to be used. On medium or poor land it is usually necessary to apply acid phosphate to the amount of 150 to 200 pounds per acre. It



A wheat harvest in Tennessee

should be applied at the time of seeding and drilled in with the same drill that seeds the crop. Ordinarily the plant food most needed is nitrogen. This is furnished in the form of nitrate of soda and applied as a top dressing. For winter oats or for spring seeding in the southern district, it is applied the first part of March and for spring oats in the northern district in the latter part of March.

Soil Preparation—One of the greatest mistakes in grain cultivation is the poor treatment given to the soil. When oats follow corn the corn ground should have been plowed deep enough so that the next plowing for oats need not be so deep; in fact, if the corn has been well cultivated and the stalks taken off, a good disking followed by the harrow will be sufficient. If winter oats follow a crop taken off earlier in the summer, plowing

for the oats should be done as early as possible and the ground should afterwards be surface cultivated by the disk or harrow, frequently enough to keep down weeds and keep the soil in good tilth.

Methods of Seeding—Of course, oats or any other grain crop should be sown only with the drill or by such other method as will give the crop similar conditions. The seed should never be broadcasted.

The Open Furrow Method—What is known as the "open furrow" method is a good practice. By this method a machine is used on which the hoes are considerably farther apart than on the ordinary drill, each preceded in front by a shovel which opens a furrow similar to the listed furrow in corn planting, though not so wide and deep as the latter. By this method the seed is put in deep in compacted soil, thus favoring germination and root formation and the plants are thereby protected from danger of heaving of the soil by freezing. A number of experiments have shown that the yield per acre resulting from the use of this method is considerably greater than that following the use of the drill and, of course, much better than the yields following broadcasting. The rate of seeding, also, is a little less per acre by the open furrow method than by the use of the drill.

Time of Seeding—The time of seeding winter oats in the Cotton Belt states is anywhere from October 15 to November 15, a good medium date probably being the last of October. In the northern area, the date may be one to two weeks earlier. Spring oats should be sown about February 15 in the Cotton Belt and about March 1 farther north, these dates, of course, being subject to variation because of changes of seasons or for other reasons.

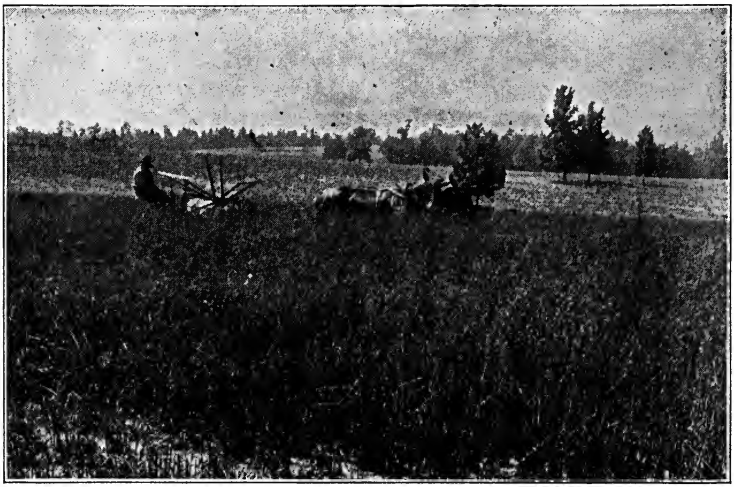
Rate of Seeding—The rate of seeding is from one and one-half to three bushels per acre. A good average rate with well-cleaned seed should be about two and one-half bushels in the case of broadcasting; two bushels if drilled; and a little less than two bushels by the open furrow method.

Winter-killing—Winter oats are much subject to winter-killing and therefore much advantage results from the selection of hardy strains. Such strains are being developed by the United States Department of Agriculture and occasionally farmers will be given the benefit of new varieties considerably hardier with respect to winter-killing than others now grown. Winter-killing may be partially prevented by other means, such as the open furrow method of seeding already mentioned, and any means of compacting the soil about the roots. Occasionally the roller may be advantageously used to press the earth around the

plants as soon after a freeze as the ground is in condition to permit its use.

Pasturing—If the crop is likely to joint before the occurrence of freezes in the fall, or, too early in the spring, damage by frost can be prevented by pasturing. All fall-sown grain crops can be advantageously pastured if this is practiced with due regard to other conditions. Stock should never be turned on when the ground is wet, and care should be taken at any time that the grazing is not too close.

Diseases—The diseases to which the oat crop is liable are chiefly the rusts and smuts. The Red Rustproof oat resists rust to a considerable extent and where this variety is grown



A harvest scene under Southern skies

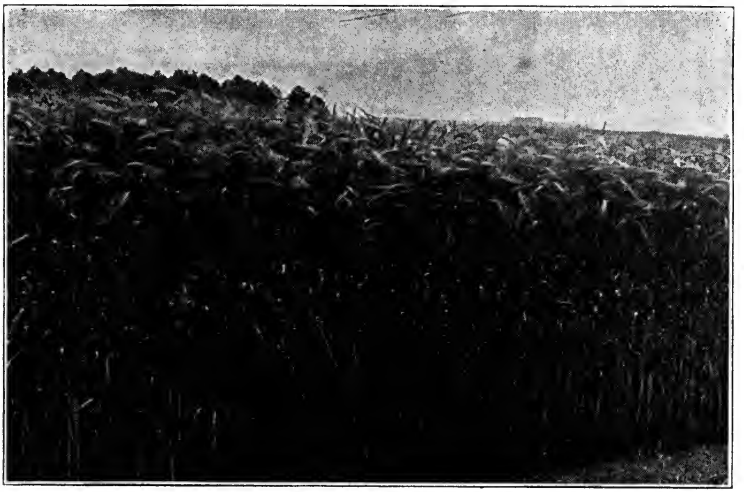
there is seldom damage from that disease. On the other hand, the Burt oat ripens so early that often it escapes the effects of the rust at the time of its greatest abundance. However, it may be worth while, in places, to select strains that are still further resistant to this fungus. There is no known preventive or remedy for rust.

The greatest damage is likely to result from loose smut. This smut, however, can be completely and readily prevented by the hot-water treatment or by the use of formalin. A complete discussion of this subject is given in Farmers' Bulletin No. 250, entitled "The Prevention of Stinking Smut of Wheat and Loose Smut of Oats." This pamphlet will be sent free to any resident of the United States on application to the Secretary of Agriculture, Washington, D. C.

One considerable advantage in the treatment of seed for prevention of smut, aside from getting rid of the smut itself, is the increased power of germination. Occasionally the germinating power of the seed is increased ten per cent, by the hot-water treatment.

WHEAT—Though wheat is not, like oats, usually employed as a food for stock, the good price it always commands in the South and the importance of producing sufficient wheat for home consumption, in addition to its desirability in a series of rotations, are good reasons for considering this crop an important one.

Varieties—Among the principal varieties of wheat grown



A wheat field in Tennessee

in the South are the Blue Stem, Red May, Fultz, Fulcaster, and Poole. Throughout the Cotton Belt by far the most common is the Blue Stem, a beardless variety with a bluish or purplish straw. It is also often called Purple Straw. North of the Cotton Belt, this variety is not commonly grown, but is there replaced by the Fulcaster, Poole, Fultz and others. The Poole and Fultz are also beardless varieties and good standard wheats. The Red May is beardless and rather early in ripening. The Fulcaster is a bearded wheat and one of the best varieties east of the Mississippi river, but apparently not so well adapted to Southern conditions as to the North.

Soil—The soil for wheat, as for oats, should be some kind of clay loam with considerable organic matter, and not acid. The application of lime to wheat soils is probably always an

advantage in the South, but it is particularly necessary if there is any tendency to acidity in the soil. Where much needed, lime should be applied at the rate of 1,500 to 2,000 pounds per acre. A somewhat smaller quantity would probably be an advantage in many cases. The liming should be done some time before the seed is planted. It may be applied through the grain drill but if spread on the surface should be covered with the harrow.

For the purpose of preventing the ravages of the boll weevil through the use of other crops, and to put the soil in good condition for wheat, it is important to give much attention to the use of legumes. Many leguminous crops are adapted to the South, such as cowpeas, soy beans, sweet clover, red clover, crimson clover, and, in the western portion, Japan clover. These are all excellent, wherever they are adapted, for preceding the wheat crop.

Rotations—It is important to precede wheat with some leguminous crop, preferably cowpeas. The wheat may either follow corn with which cowpeas have been sown or it may follow a crop of cowpeas sown alone. In the latter case some other crop, such as oats, may precede the cowpeas the same season. With crimson clover the following four-year rotation may be advantageously arranged, viz., first year, cotton, with crimson clover sown later between the rows; second year, cotton; third year, corn with cowpeas; fourth year, wheat followed by cowpeas. Where red clover can be grown a good three-year rotation would be as follows: first year, wheat sown with red clover; second year, continuation of the red clover; third year, corn.

Fertilizers—Ordinarily it will be necessary to use fertilizers for wheat. Acid phosphate is apparently a little more necessary than in the case of oats, while on poor soils, such as those much inclined to be sandy, potash should be applied. A proper proportion of commercial fertilizers would usually be 150 to 200 pounds of acid phosphate, 25 pounds of potash, and 80 to 100 pounds of nitrate of soda per acre. As in the case of oats the acid phosphate and potash should be applied at the time of seeding. The nitrate of soda is applied as a top dressing some time in March, or about three months before harvest.

Soil Preparation—An important feature of cultivation is early and deep plowing unless the wheat is preceded by a cultivated crop. It is a safe rule never to leave the ground idle for any length of time after the preceding crop is removed. It should be at once plowed or otherwise treated for the crop that is to follow.

Seeding—Other practices to be observed in soil preparation, and method and time of seeding, are about the same for wheat as

for oat cultivation. The date of seeding wheat, however, should be somewhat later than that of sowing winter oats, partly because wheat is a hardier crop, but also because of the attacks of the Hessian fly. As the Hessian fly is killed by frost a good practice is to sow after the first killing frost. In the Cotton Belt the time of seeding would run from about October 1 to November 10, or an average date of about November 1, though wheat is sometimes sown as late as the last week of November or the first of December. In the northern district the date should be from October 20 to November 1, or an average date of about October 25. In the mountainous districts, seeding should be a little earlier than nearer the coast.

The proper rate of seeding for wheat may vary from one to one and one-half bushels per acre. An average rate for good well-cleaned seed, sown with a drill, should be about five pecks to the acre.

Winter-killing and Pasturing—Wheat being a hardier crop than winter oats there is less danger that it will be winter-killed. Care should be exercised, however, in pasturing wheat. The ground should not be soft when the stock is turned on and the wheat should not be pastured close.

Diseases—Concerning wheat diseases the same remarks may be made with reference to rust that apply to oats. There is no remedy or preventive, but there is a chance for improvement in the way of selecting more rust-resistant strains. The common smut of wheat, known as stinking smut, can be easily and thoroughly prevented by either the hot water or formalin treatment. Instructions as to the use of these methods are given in Farmers' Bulletin No. 250, entitled "The Prevention of Stinking Smut of Wheat and Loose Smut of Oats."

The importance of treating both wheat and oats for smut cannot be too much emphasized. Often crops are destroyed to the extent of 10 to 40 per cent by these diseases and yet any loss at all can be readily prevented.

Seed Selection of Small Grains—In the case of any of the small grains it is of the greatest importance that farmers should use each year a high quality of seed. This can be accomplished only by keeping the crop pure from other varieties, and, by the use of the fanning mill, selecting the heaviest and largest kernels. Other cereals should not be allowed by careless methods in threshing or through any other means to become mixed with the crop that is being grown. If this should occur, however, the seed of different cereals may often be separated by what is known as the "specific gravity method." This is described in Bureau of Plant Industry Circular No. 62, entitled "The Separation of Seed Barley by the Specific Gravity Method," and is

a simple method of immersing the seed in water, allowing the kernels of the lighter cereal to float to the top when they can be skimmed off. This process of separating grain mixtures may be combined with the hot-water treatment for smut, thus performing both operations at the same time.

In addition to keeping seed pure, the farmer may greatly improve his crop by the selection of better plants each year. This may be accomplished by the following method. Just before harvest select from the field vigorous, healthy plants that have stooled well, that have large heads and that are free from rust or smut. Continue the gathering of these plants until after threshing you have enough seed to plant an acre of ground. This space is to be known as a seed plat and its size year after

A field of rye in Dixie Land

year, of course, should depend upon the acreage of grain that is to be planted. In this seed plat is grown only the grain that is to be used for sowing the general crop the next year. If this seed selection becomes a regular custom, as it should, the farmer will be justified in buying a small one or two-horse power thresher that can be run by a gasoline engine, which will readily thresh any small-sized bundles, as small even as a mere handful. The seed plat should be set apart from any of the fields and kept thoroughly protected, even fenced in if necessary. Just before harvesting this seed plat, the very best plants should be selected from the plat in the manner described, and the seed of these plants should be used for sowing this seed plat the next autumn or spring. The remainder of the seed that is taken from the seed plat should be used for seeding the general crop.

Continue the same method from year to year, always using the best seed from the seed plat for seeding it again and the remainder of the seed for seeding the general crop. In this way no seed is ever taken from the general crop, yet it is constantly improved, and is better than imported seed.

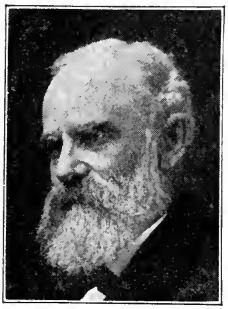
Harvesting—In harvesting both wheat and oats it is always better to cut the grain a little early rather than late. Overripe grain becomes bleached, or will lodge, or be damaged otherwise. The heads should turn to yellowish white or golden color, but the straw should yet remain a little green. A fair rule to follow is to harvest when the kernel on being pinched between the thumb and finger can be only slightly dented by the finger nail. The grain should be fairly dry when cut, though a slight amount of dew may not be an injury. Grain is sometimes cut with a self-rake reaper or even occasionally with a mower, and, in the latter case, left to dry awhile and then raked into windrows and finally put in cocks. These methods, however, are slow, expensive, wasteful, and likely to be damaging to the grain. The best method of all, when possible to follow it, is to cut with a self-binder, put the bundles into well-constructed shocks soon afterwards; then, after curing a few days or a week, put the bundles in a stack or in the barn.

RYE and BARLEY are at present comparatively unimportant crops in the South. Considerable attention, however, has been given recently to the barley crop and it probably should be grown considerably more than at present. Barley is excellent for pasturage and good for feeding stock, particularly hogs. All barley and rye should be sowed in the fall. Other advice with respect to these two crops would be about the same as that given for the cultivation of oats and wheat.

Grasses and Leguminous Crops in the South

By S. M. Tracy

Special Agent in Forage Crop Investigations, U. S. Department of Agriculture, Biloxi, Mississippi



Every region has its own special assortment of forage crops, and each crop needs its own special location and management. The South has a greater number of profitable forage crops than has any other section of the country, though the red clover, timothy, red-top, and other common forage crops of the North are almost unknown. This difference in the kinds of forage does not indicate that the Southern crops are in any way deficient in yield or quality, but simply that crops change with soils, climates, and conditions. In fact, the yields per acre are greater in the South than in any part of the country. The Year-book of the U. S. Department of Agriculture for 1909 gives the 10-year average for the whole of the United States as 1.44 tons per acre, while the average for Texas, Louisiana, and the states east of the Mississippi river was 1.54 tons per acre. Not only is the yield greater in the South, but prices are much higher. The 10-year average farm price during the same years for the entire country was $11.62 per ton, while the price in the Southern states named was $17.33 per ton. In other words, the average cash yield per acre was $16.73 for the whole of the United States, while for the Southern states it was $26.68 per acre, or nearly 60 per cent greater than the general average.

A Wide Range of Profitable Crops—To produce these heavy yields and satisfactory profits, the South has a large number of crops available, Bermuda and Johnson grasses being among those commonly used for permanent meadows, while alfalfa, melilotus, Dallis grass, lespedeza, and others are of great value in certain regions. It is easy to secure good, permanent pastures, yet permanent meadows are less common and of less importance than in the North. A large part of the hay made in the South is from annual plants which are grown in the fields when they are not occupied with growing cotton, corn, or other grains. In all the country south of the Ohio river it is possible to have

some growing crop on the ground at all seasons, and so many hay crops are grown at times when the fields would otherwise be idle.

Bermuda, The Blue Grass of the South—Bermuda grass is to the South, what Kentucky bluegrass is to the North—the foundation of the best permanent pastures. On rich and fairly moist soils, it makes two to four tons of hay per acre, in two to three cuttings. It is a grass which needs a good soil to make a profitable hay crop, but the hay is of fine quality, having no coarse stems and no waste. It is the best hay grass for rich river-bottom lands, and the best pasture grass for all excepting very sandy or thin clay soils.

It is usually propagated by planting small pieces of the sod, which may be done at any time from April to August. If the

Where alfalfa shocks are plentiful

field is wanted for a meadow the ground should be well-plowed, and harrowed until the surface is level and smooth. Sods, which need not be more than an inch in thickness, are taken from an old Bermuda field and chopped into pieces half an inch or more in diameter. These pieces are then dropped three or four feet apart on the freshly prepared ground, and are easily covered by pushing them into the soft ground with the foot. When planted early in the spring, the plants will make a heavy growth the same season, but July and August plantings will do little more than cover the ground before cold weather. If the field is wanted for a pasture, less care is necessary in planting, and a common method is to run shallow furrows four to six feet apart, the pieces of sod being dropped in these furrows and covered with the foot, or a hoe.

When sods are not available seed may be used, but it is usually slow and uncertain in germinating. The ground for

seed must be made very fine and mellow, and the seed sown at the rate of five pounds per acre at cotton-planting time.

Johnson Grass Is Used Extensively for Hay—This grass makes a rank growth on heavy, loam soils. It gives two or three cuttings annually, with a yield of three to six tons per acre. The hay is rather coarse, but is eaten well by all kinds of stock, and liverymen prefer it to any other. It does not bear trampling well, and soon becomes weak and stunted when the land is used as pasture. It makes its best growth on the heavy, black, lime soils, but even there the field should be plowed and harrowed once in two or three years to prevent the roots from becoming so matted and dense as to check the growth and decrease the yield. Many farmers plow the land annually in September and then sow with a mixture of winter oats and vetch, which gives the best of winter grazing, and, if stock is taken off in March, a heavy crop of hay may be harvested in May,

The soy bean supplies a wealth of forage

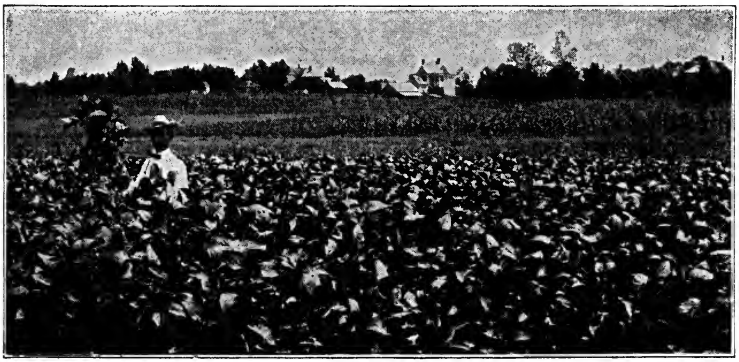
which will permit two heavy cuttings of the Johnson grass later in the season. The one serious objection to its cultivation is the fact that it spreads easily and is difficult to eradicate when once established in a field. Many farmers object to it on that account.

In seeding Johnson Grass the land should be prepared as for wheat or oats, and the seed sown at cotton-planting time at the rate of one bushel per acre, and covered by harrowing.

Alfalfa Is Adapted to Some Sections—Alfalfa makes a vigorous growth and a heavy yield in some sections, but is worthless in other localities. It does well in all of the "black prairie" belt of Alabama and Mississippi, on the alluvial soils along the Mississippi, Yazoo, Red, and other large rivers, on the "black wax" lands of eastern Texas, and on practically all river-bottom lands where there is a well drained subsoil and where the surface soil is rich in lime, but has never been a profitable crop on

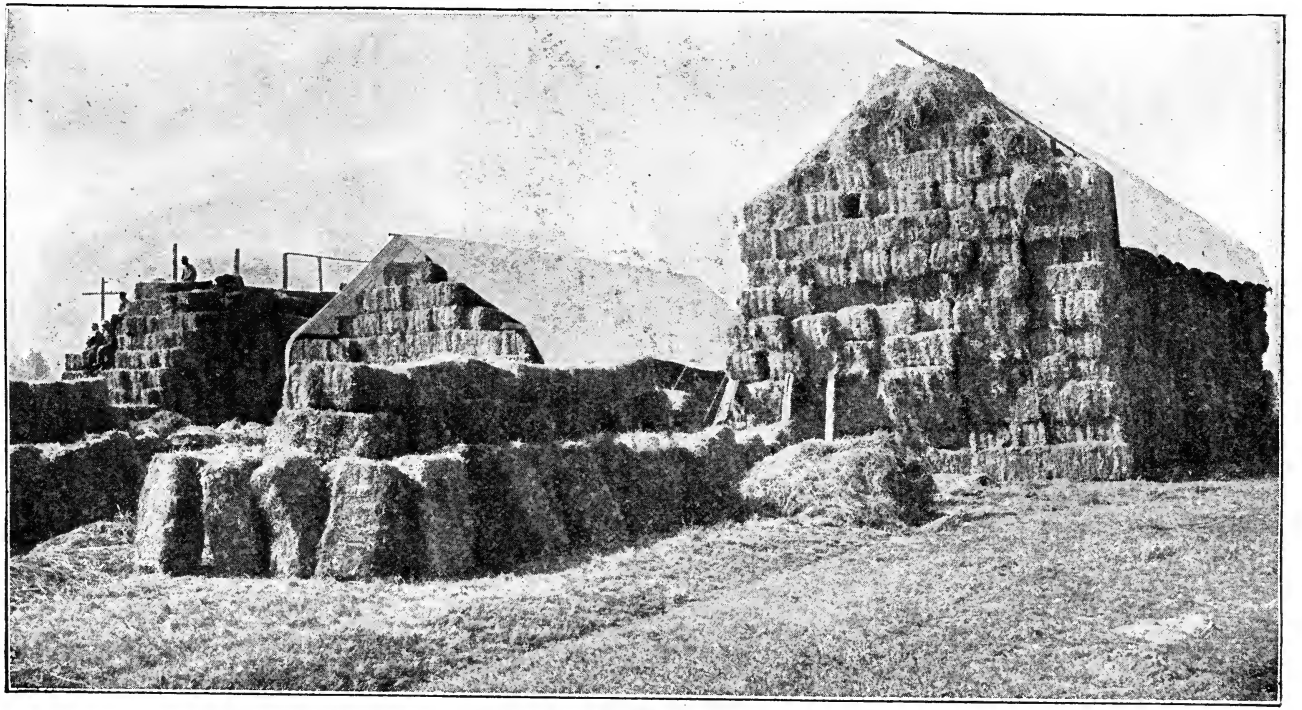
any part of the sandy, pine wood region. On suitable soils it makes four to six tons per acre in about as many cuttings, and the hay always commands a high price. A large part of the good alfalfa lands are more or less set with Johnson grass, but the growers regard that as an advantage, as the latter gives a heavy cutting late in the fall after the alfalfa has nearly stopped growing, and the total yield is considerably increased. Most feeders prefer the mixed hay to that made from either plant alone. Alfalfa always grows well on the sugar lands of Louisiana, but is usually killed by root-rot at the end of its first season. Many sugar planters, however, regard it as the best crop for their rotation, not only because of its heavy yield of hay, but also for its fertilizing and rejuvenating effect on the soil.

The seeding of alfalfa requires more careful work than the planting of any other forage crop. The ground should be plowed



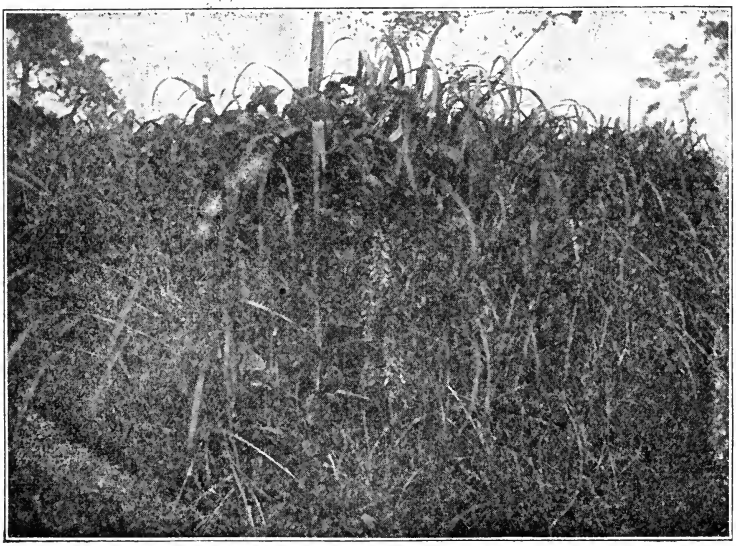
Cowpeas improve the soil

as deep as possible at least two months before the seed is sown, though the plowing or disking immediately before seeding should be as shallow as possible to make a good seed bed. If the ground is plowed deep just before seeding, the roots of the fall-sown seed are likely to be pulled out by frost, while the spring-sown seed is sure to suffer more from drouth than when the subsoil has been well compacted. Seeding may be done in either fall or spring, though fall is much the better time in the South. The best preparation of the ground is by plowing deep in the spring or early summer after a crop of oats has been removed, and then growing a crop of cowpeas on the land. As soon as the peas are gathered, in August or September, the ground should be disked, or plowed very shallow, and then harrowed until the surface is fine and smooth, the seed sown at the rate of about twenty pounds per acre, and covered with a light harrow or a roller. The Arabian and the Peruvian are the best



Alfalfa ready for the market

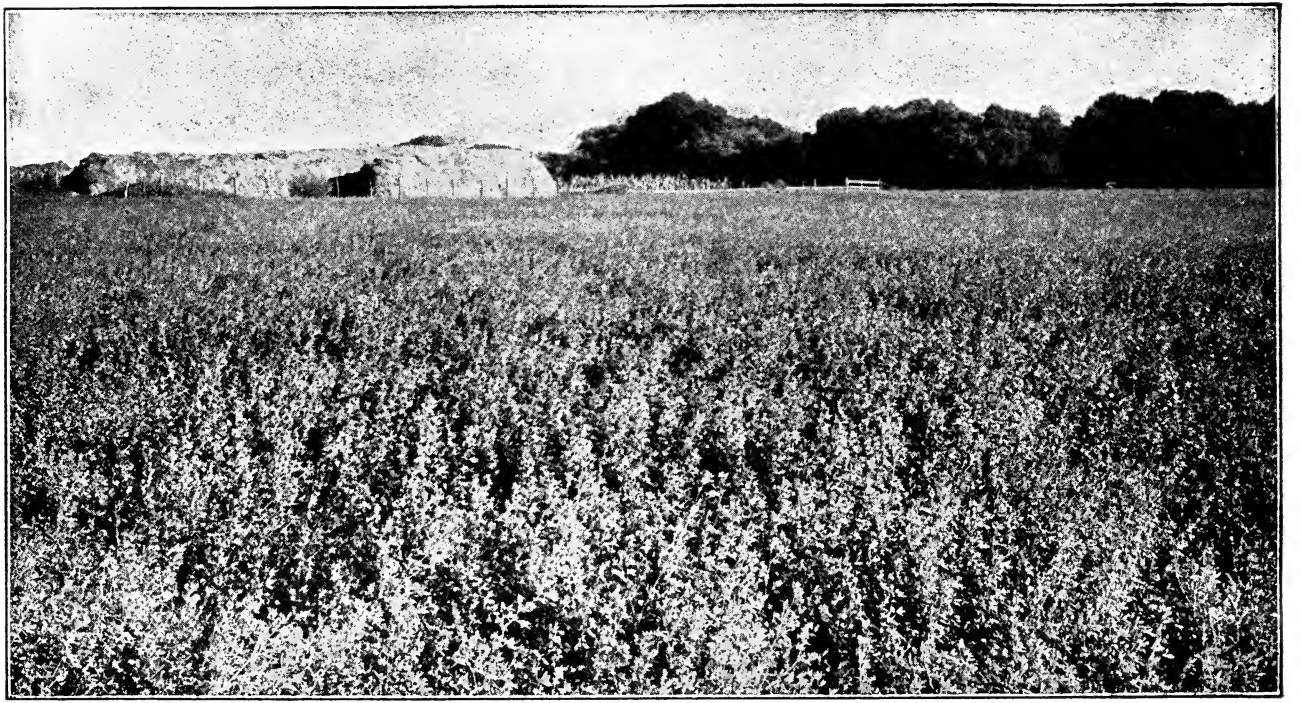
varieties for use in the South, and it is always economical to use the very best seed which can be found, even though it is high in price, as low-priced seed is always low in vitality, and is usually badly mixed with seeds of troublesome weeds. Inoculation is needed on most soils excepting those on which melilotus or burr clover has been grown within the last two years. Inoculation may be given either with soil from a field on which alfalfa, melilotus or burr clover is growing, or by using the inoculating material which is furnished by most seedsmen, and often by the U. S. Department of Agriculture. Soil inoculation is preferable, and is accomplished by scattering soil from the old over the new



Hairy vetch and sorghum cane produce an abundance of forage

field at the rate of about 200 pounds per acre. This should be done just before the seed is sown, and the ground harrowed immediately, as exposure to a hot sun or a drying wind will soon kill the bacteria in the inoculating soil. If soil is not available, it is best to use the material sent out by seedsmen, who give full directions for its use.

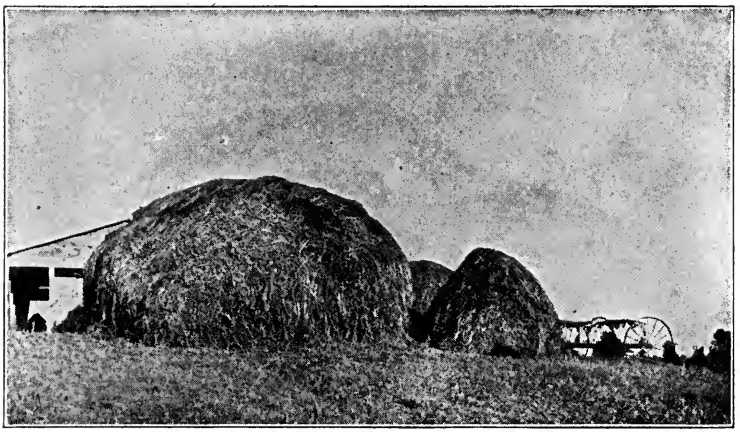
Lespedeza—Though an annual legume, lespedeza re-seeds so freely that it is usually treated as a perennial. It grows best on a rich, clay loam, where it reaches a height of two feet or more and makes a yield of two or three tons per acre of hay worth fully as much as that from red clover. It will also grow on very dry, hard clay along roadsides and other waste places, but there its growth is so flat and spreading that it cannot be cut for hay,



A heavy crop of alfalfa

though it makes fine grazing. When wanted for hay, it is usually sown with winter oats, the oats being sown in September or October and grazed through the winter. About February the field is harrowed and the lespedeza seed is sown at the rate of half a bushel per acre; the oats are harvested in May, after which the lespedeza makes a vigorous growth and is ready for cutting in October. Though it re-seeds the ground so freely it never becomes a troublesome weed, as it is killed by a single plowing at any time before the seed ripens.

Cowpeas—As said before, temporary hay fields are more common in the South than are permanent meadows, as the growing season is so long that it is often possible to secure a good hay crop when the field is not needed for other crops. The most important of these annual hay crops is the cowpea, some varieties



Cowpeas ready for the thresher

of which will make a good yield of hay during any two months of warm weather, while other varieties may be used to occupy the ground through the entire season. All varieties will mature if sown after oats or other early crops have been harvested, and all mature so early that the land may be used for the fall sowing of wheat, oats, alfalfa, or other winter-growing crops. A large part of the crop is grown in cornfields, the seed being planted when the corn is being given its last cultivation. The peas do not interfere with the growth of the corn, and after the corn is gathered a good crop of hay is secured which has cost nothing but for the planting and gathering. Of course this hay is mixed with the cornstalks and the weeds which may have grown since cultivation ceased, and is rough and coarse, but of high quality, and makes one of the best of feeds. Mules fed on this hay, with no grain feed, go through the winter in fine condition, and there

is no better feed for milch cows. When cowpeas are grown alone, the yield is much larger than when grown with corn, the hay is finer and of still better quality, but is more expensive as the ground is making no other crop at the same time. The cowpea is one of the best fertilizing and renovating crops, and its effects on the soil fully repay the cost of planting and cultivation, leaving the hay crop as clear profit. Any land which has made a good yield of cowpea hay is always in an ideal condition for the production of any other crop the following season; and there is no other summer crop which is better for preparing the ground for oats, alfalfa, or any other crop to be sown in the fall.

Planting may be done at any time from April until July, and the amount of seed needed varies with the time and method of planting. When sown broadcast, or in corn at its last culti-

A modern mower cutting hairy vetch

vation, one bushel per acre is commonly used; but when sown in drills half that amount is sufficient; and when any of the strong-growing, long-season varieties are sown in the spring not more than a peck per acre is required.

Soy Beans—Of more recent introduction, soy beans promise to become almost as important as cowpeas, as they produce seed more freely; some varieties are equally good for hay, and all are equally good in their effect on the soil. Of these there are two principal types: one has a heavy, erect stem with few branches and is too coarse for good hay, but produces an immense yield of seed; while the other makes numerous long and slender branches which are fine for hay, but which produce less seed than the erect

sorts. The Mammoth Yellow is one of the best of the erect types, and the Barchet of the branching varieties. The latter are usually more satisfactory in the extreme South.

In seeding soy beans, the crop should always be planted in drills and given one or two cultivations, as it does not succeed as well as cowpeas when sown broadcast. The main crop should be planted at about the same time as cotton, from two to three pecks of seed being used per acre. When some of the short-season varieties are used, either for an early crop or for planting late in summer, about a bushel of seed should be used, as the rows can be put much closer than with the larger growing strains.

Velvet Bean—Along the Gulf coast and for some distance farther north the velvet bean has recently become an important forage crop, especially for winter grazing. It makes a much heavier growth than does either the cowpea or the soy bean, and

Stacking alfalfa hay

the vines and beans give good grazing through the winter, but it must be planted early in the spring, and so occupies the ground through the entire season.

To plant an acre one peck of velvet beans will answer when planted carefully by themselves, on good ground; but when planted on very thin soils, or with corn, it is better to use a bushel per acre.

Sorghum—Another forage crop of great value, especially in southern Texas and southern Florida, where it furnishes a good part of the hay for home use is sorghum. The hay is coarse, but of good quality, and as the crop has a long season of growth it makes about three cuttings, with often a yield of ten tons per acre.

In planting sorghum it is usually best to plant the crop early, at about the time corn is planted, a bushel per acre being

used when sown broadcast, though when in drills and cultivated, one-third that amount is sufficient.

Other Grasses and Clovers Flourish—Many other forage crops are grown, among them Dallis grass which is grown from northern Georgia westward to northern Mississippi, and which not only makes a heavy yield of hay similar to that of timothy, but is also one of the best winter pasture grasses. The so-called Mexican clover is not a true clover, but is a volunteer crop which furnishes great amounts of both hay and pasture in southern Georgia, Alabama and Florida. Beggar weed flourishes on all the sandy soils near the coast, where it springs up in the corn and cotton fields after the crops are laid by, and enables the dairyman to make good "June" butter in January. Texas and Florida growers make six to ten tons of hay per acre from para

Baling hay without horses

grass, and the despised crab-grass of the North often makes two tons of hay per acre as a volunteer crop, costing nothing but the cutting. Melilotus, the "sweet clover" of the North, covers thousands of acres of the lime lands and makes a hay which can scarcely be distinguished from alfalfa. The vetches, burr and crimson clovers, guinea grass, cassava, and many others might be mentioned, but enough has been said to show that no other part of the country has a greater variety or more productive and profitable kinds of forage crops than are to be found in the South.

For further information on forage crops for the South, write the U. S. Department of Agriculture, Division of Publications, Washington, D. C., for Farmers' Bulletins Nos. 89, 102, 147, 300, 312, 318, 339 and 372.

Texas Fever Tick

By Dr. Mark Francis,
Professor of Veterinary Science, Texas Agricultural College

For many years it has been generally known that if cattle raised in what are known as the Northern States be taken south into the South Atlantic and Gulf States, after a few weeks they become sick and die of an obscure disease called "acclimation fever," "bloody murrain," or "Texas fever."

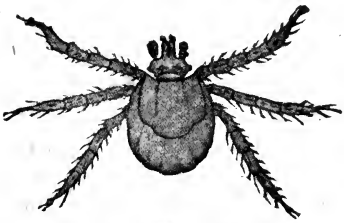
Not Confined to a Small District—This disease is widely distributed, affecting cattle in all parts of the torrid and subtemperate zones having a low altitude. The disease is due to the invasion and destruction of the red blood corpuscles by a minute animal parasite of the same general character as the malarial organism of man. It is conveyed from one animal to another by the *Cattle Tick* only. These two facts are the essential features of this subject, and should be kept in mind.

How the Disease Is Propagated—The blood of most cattle that have been raised in the Gulf states contains these parasites, though the animals may appear to be in good health. If the common ticks (*Boophilus annulatus*) mature on these infected cattle, their progeny will be virulent and be capable of infecting any cattle which are not immune to the disease in question. When the female cattle tick matures, it falls to the ground, and crawls to some dark and suitable place to deposit its eggs. In ten days or so, she will have produced about two thousand eggs. She then dies. Some species of tick produce several crops of eggs, but this one lays eggs but once.

This simple fact is important, as it greatly simplifies the problem of tick eradication to be mentioned later. The eggs which have been laid will hatch in three or four weeks if the weather conditions be favorable. In winter it may be several months before the eggs hatch. The young ticks have but six legs. We call them larvae. They crawl up on the grass or weeds and simply wait until some animal passes their way, to which they can attach themselves and secure blood which seems necessary for their development. If no cattle or other suitable animal happens to give them this opportunity, they perish for lack of

food. It is remarkable, however, that they may live four to six months without apparent source of food.

If they find an opportunity to attach themselves to cattle, they do so, moult several times, copulate, and when mature, the adult female drops to the ground, lays her eggs, and dies. All this is familiar enough to every one who has lived in the South, but the astonishing thing about it is that the parasites of the blood should be transferred from one cow to another in this way and give rise to a very serious trouble that is costing the country millions of dollars in losses every year.

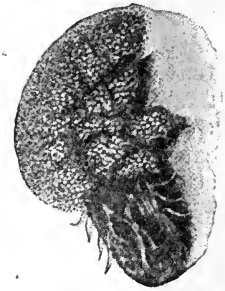


The Seed Tick

After hatching it swings from spears of grass, and attaches itself upon passing cattle. If no cattle give it succor it will die of starvation in about four months in summer, but in winter it remains dormant. By taking advantage of this fact, it is possible to free a herd of the tick in a comparatively short time.

When cattle are taken South, these young infected ticks soon find them and attach themselves to get blood. In some way that is not well understood yet, they infect the cow's blood with the germs of Texas fever.

In about ten days the cow becomes sick, has high fever, say 105° to 107°, refuses to eat, and the milk stops suddenly. This continues several days with constipation, great weakness, and often bloody urine and death. Among mature cattle the death rate may be 90 per cent or more. Among calves we find they survive as a rule. Yearlings become very sick, but 60 per cent or more survive. These often become thin, weak and stunted, but are immune for life.



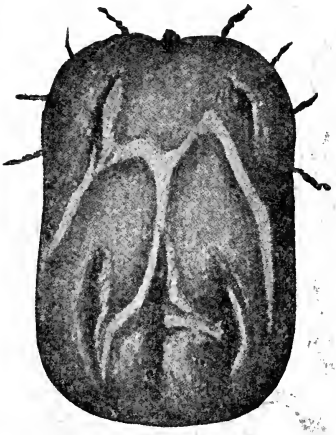
The Female Tick and Its Eggs

One tick is capable of laying 4,000 eggs within a week's time. In summer the eggs hatch in about three weeks, while in fall and winter they will lie dormant.

There is no Medicine that will Cure this Disease—If we examine a dead animal we find ticks on the body; the fat is yellow; the blood, very thin and watery from extensive destruction of the corpuscles; the spleen enormously enlarged; and usually the bladder contains bloody colored urine. We have no medicines that cure this disease. If we give a large dose of Epsom salts, say two to three pounds, to a 1,000-pound cow early in the attack, it often cleans out the bowels and enables the cow to throw off her waste products and thus saves her life. Medicines to

"reduce the fever," are unsafe and positively dangerous to use because the heart is usually involved.

When the fever falls, we must be very careful, because the animal is then very weak. We seem to get good results from stimulants, say small doses of whiskey and tincture of nux vomica, but these must be given with great care and moderation. In a week or so the animals regain much of their lost flesh and spirit and appear to be entirely well again. It is quite usual, however, to find relapses after some weeks. These may be frequent and severe enough to bring about extreme emaciation, weakness, drowsiness, and an unthrifty condition that may require a year or more to fully pass off. In such instances, the animal often becomes stunted for life.



Engorged Female Tick

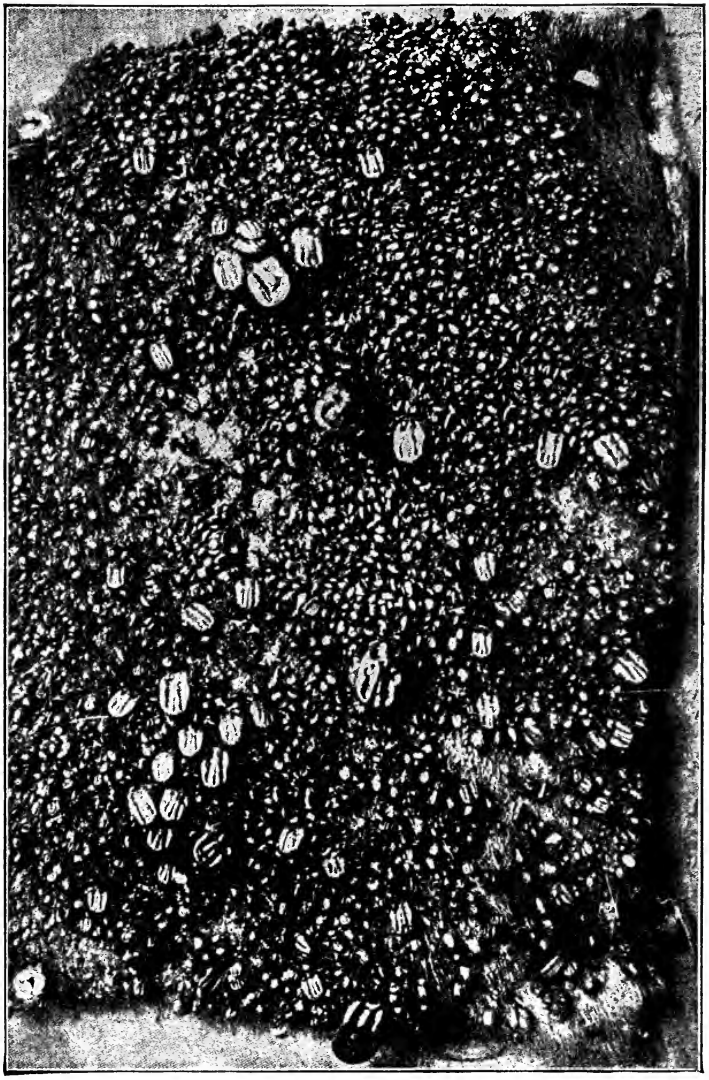
By feeding upon the nourishing blood of the cow, the female tick reaches maturity. It then falls to the ground where it deposits its eggs, thus greatly increasing the number of cattle ticks.

How to Prepare Cattle that are to be taken South—If you decide to take some cattle South, take the matter up with your experiment station some months in advance, so that you may follow out a definite working plan. The following one succeeds quite well:

About April or May select a suitable pasture of say ten to twenty-five acres and allow no native cattle to enter it from that date. A field that is in cultivation will answer. See that it is fenced in a substantial manner. About October plow up several acres and plant oats or a mixture of wheat and rye so as to have green winter pasture. Provide suitable barns and shed room, and a reliable water supply. About December or January buy young cattle, say from ten to eighteen months of age, and have them shipped south in a clean, disinfected car, without unloading until they reach their destination. They must be fed and watered in the car and some reliable man must accompany them to see that these essentials are strictly observed. You must not permit them to be unloaded into stock pens along the route.

In case you buy only one or two animals they should be crated and sent by express. When they reach your depot, load them onto the wagon directly from the car and haul to the pasture you prepared some months previously. You should not buy adult cattle, as the death rate is very high among them.

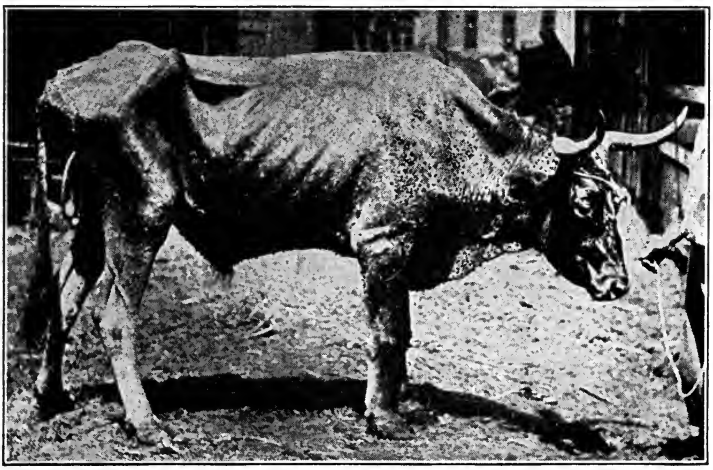
How to Inoculate—In a day or so vaccinate them for blackleg. After they have rested a week or so, they may be inoculated for Texas fever. Proceed as follows: Halter the calves and tie



The Texas fever tick as it appears on infested cattle

them in a row to the fence, or have them in a small pen so you can treat them rapidly. Now go among your native cattle and select a young, healthy one, say two or three years of age that

has some ticks on it. Secure it with ropes so it can't struggle much. Tie a heavy hemp twine around its neck tightly, so that the jugular vein will become distended with blood. Force the needle of a large, clean, sterile hypodermic syringe into the vein and fill the syringe with blood. Withdraw the needle, and immediately inject about one-half drachm of the blood under the skin of each calf. It is important to have enough labor at hand so that you can do this rapidly and accurately. It is very easy during the hurry to overlook a calf or to give one two doses of blood if you have not each one haltered and tied. No sickness will be noticed for about eight to ten days. About this time you will find a marked fever, running from 103.5° to 106°. The calves will refuse to eat, lie down most of the time, and in severe

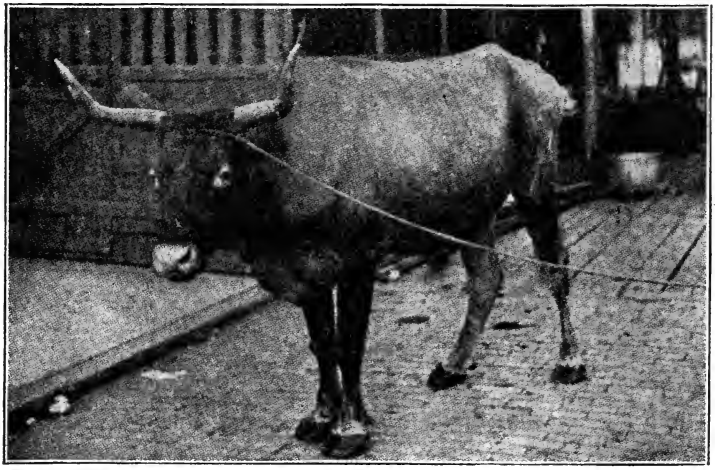


Tick infected steer—August 12, 1911. Weight, 730 pounds

cases pass bloody urine and some of them may die. This fever period lasts three to six days as a rule, and then passes off. The important thing to do is to keep the bowels active. To do this we pasture them on green stuff, and if there be some indications of constipation we give a large dose of salts, say one-half to one pound. About the 30th day after inoculation a second fever period begins, which is very similar to the first one. We expect it and handle the calves as before. It is usually fifty to sixty days before the calves are strong enough to permit the ticks to attack them. During the spring months we let them mingle freely with Southern cattle and ticks, but about May or June it is best to keep them to themselves until October and feed them once a day. We find one-half pound of cotton-seed meal per day is enough for a calf weighing 500 to 800 pounds. A compilation of the work done by the Southern experiment stations shows

that by this plan of treatment and management it is quite easy to save over 90 per cent of Northern cattle. This is now a demonstrated fact and can be accepted with confidence, and positively shows that breeders are justified in buying strictly first-class animals to improve the native stock.

Extermination of Tick—There are two ways of dealing with the tick: Either exterminate him by simply starving him to death while he is in the larva stage, which requires only four to six months, or destroy him while on the body of the cattle. The former is the simplest, cheapest, and most efficient method. It seems too simple to be of real value. A review of the life history of the tick suggests the thing to do. It is this: Simply turn all cattle out of pasture A, into pasture B. From B move

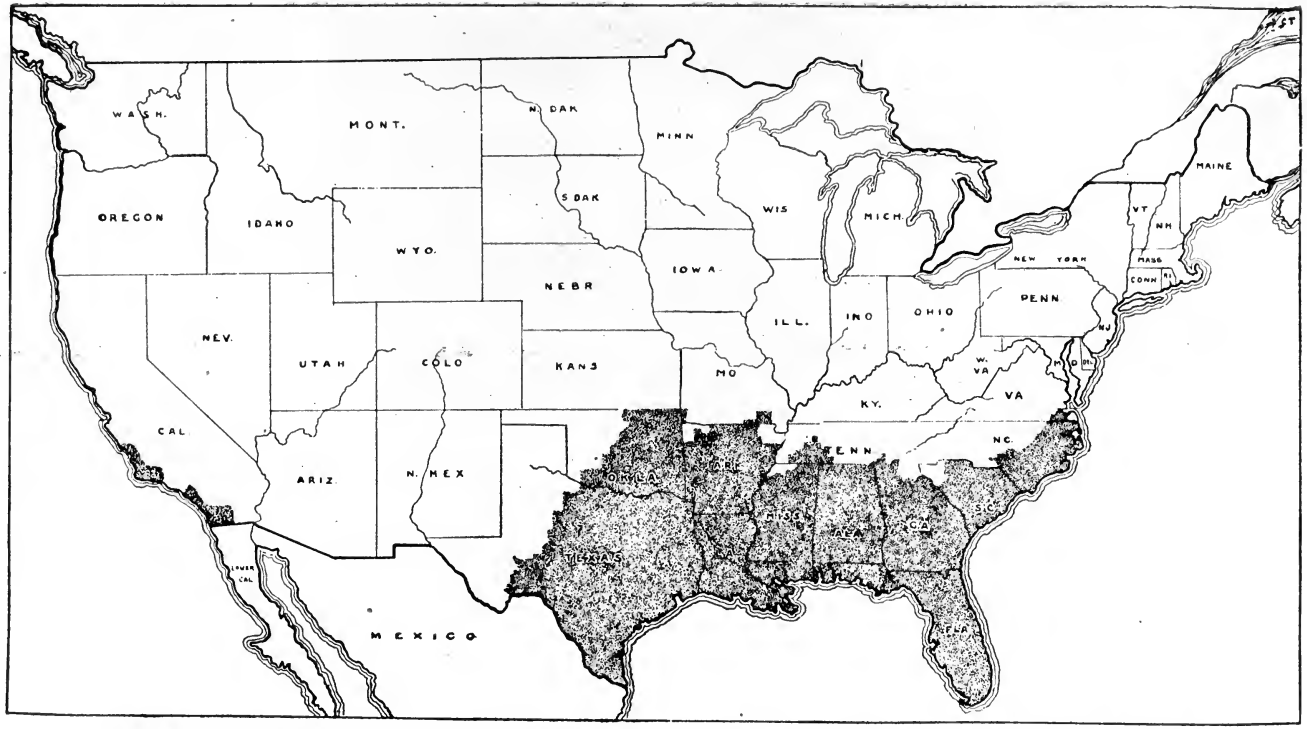


Same steer free of ticks—October 12, 1911. Weight, 1,015 pounds

them into C, from C to D. Now time this so it will be about six months before you return to A. A moment's study will show that you leave the ticks behind to perish of starvation before you return the cattle to them. Every one who is at all familiar with the tick has noticed that there are times when there are very few or almost no ticks on cattle. This is important, as this is exactly the time to move to a clean pasture. Cattle men are very reluctant to disturb their animals at such times, but this is the time to move.

A great many suggestions have been made about feeding cattle sulphur and other things to cause the ticks to fall off. These are of little or no value. There are several types of medicines to be applied to the cow's skin to kill the tick:

1st. Grease or oil of any kind is very fatal to ticks. Lard,



Map showing the region where the cattle tick is found, the shaded portion indicating the infested area

cotton-seed oil, or crude petroleum may be applied with success.

2nd. Sometimes the rosin oil emulsions of crude carbolic acid, of about a 5 per cent strength are used. These preparations kill the tick fairly well, but are not very stable, are volatile, and very irritating if used too strong.

3rd. Solutions of arsenic are now used with great success. The following is the formula given by the Bureau of Animal Industry:

ARSENICAL CATTLE DIP.

(See Bureau An. Ind. Order No. 168)

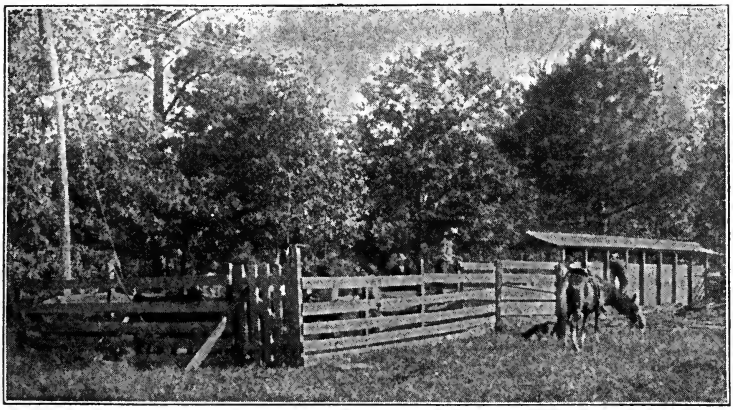
Powered White Arsenic - - -	10 pounds
Sal Soda - - - - - -	25 pounds
Pine Tar - - - - - -	1 gallon

A dipping vat showing liquid in place ready for use

Boil the arsenic and sal soda together for at least fifteen minutes, or longer, in at least twenty-five gallons of water, until all the arsenic is dissolved. Remove from the fire and cool by adding water to reduce the temperature to 140 degrees F., then add the tar slowly, in a fine stream, stirring vigorously while doing so. Then add water enough to make up the whole 500 gallons. It is now ready for use.

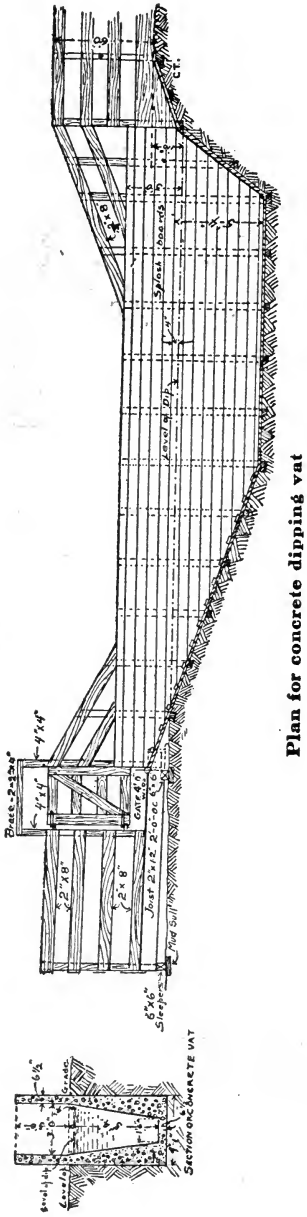
A Dipping Vat is Very Essential—The arsenic dip may be applied with a spray apparatus, or a large dipping vat may be built, which will permit the treatment of 2,000 head of wild range cattle per day.

The arsenic preparations are somewhat slow in their action, so that if cattle be examined, say, forty-eight hours after dipping, some ticks may be yet alive, but as a rule they have received a fatal dose that causes their death.



Dipping vat on I H C demonstration farm at Brookhaven, Mississippi

Special bulletins, giving further details about these matters, and plans and specifications for building vats are issued by a number of the Southern experiment stations. In a small booklet of this kind, only the merest outline of this great problem can be presented.



Plan for concrete dipping vat

SPECIFICATIONS FOR THE CONSTRUCTION OF A CATTLE DIPPING VAT

The site selected for the vat should be dry. The excavation should be

Seven feet deep.
Twenty-seven feet long at the top.
Thirteen feet long at the bottom.
Four feet wide at the top.
Thirty inches wide at the bottom.

The walls and floor should be six inches thick. The wooden frames should be constructed of 2 x 4 inch braces, on the outside of which 1-inch boards are tacked. After the concrete has set, take out frame, and plaster inside of vat with a mixture of 1 part cement and 2 parts sand. The walls of the vat should be built one foot above the surface of the ground. The slide where the cattle go into the vat should be three feet long with a fall of two feet. The concrete should be made as follows

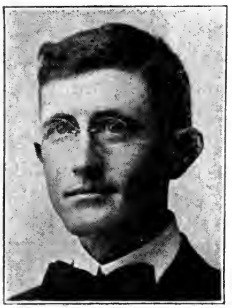
Cement - - -	1 part
Sand - - - -	2½ parts
Gravel or Broken Rock	5 parts

all thoroughly mixed.

The dipping vat should be covered with a shed and provided with convenient pens, chute, and dripping pen.

Growing Rice in the South

By F. C. Quereau
Assistant Director, Rice Experiment Station, Crowley, La.



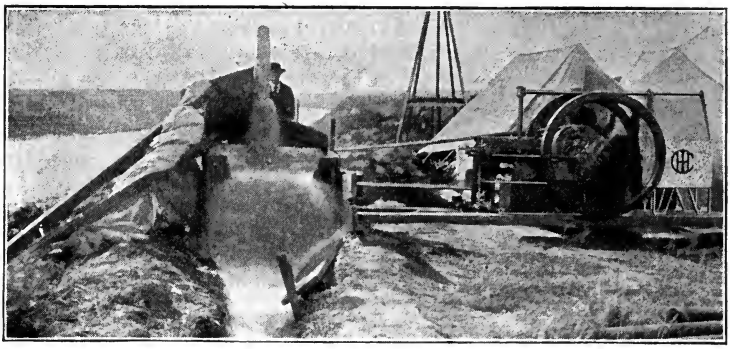
There is no doubt but that rice is the greatest cereal food in the world. It has been the principal food of Oriental races for thousands of years, and even in modern times it furnishes a staple food for a greater proportion of the world's population than all other cereals combined. Famine in the Eastern countries is always associated with a failure of the rice crop. Rice has no superior as a carbohydrate food because the starch of properly prepared rice is in an easily digested form, and when combined with meat or beans forms a well-balanced, energy-producing ration. The population of any given section or country is in direct ratio to the food supply. We cannot, therefore, have better proof of the food value of rice than in the almost marvelous density of the population of Indo-China and Japan. It is worthy of note, also, that the fertility of the soil has been maintained, and at the same time the food ration balanced by the use of the soy bean in rotation with rice.

Development of Rice Growing—Prior to 1890, the rice production of the United States was largely restricted to the Carolinas where it has been cultivated since 1694, when it was introduced from Madagascar by an English sea captain. The alluvial prairies of southwest Louisiana and Texas up to the year 1888 were the home of deer and wild fowl, and the range of the long-horn Texas steer. The native French settlers lived in isolated communities along the wooded rivers and bayous. These people maintained themselves largely by cattle raising, hunting, and trapping. They produced corn in small quantity which was ground into meal in primitive mills. Rice and meat was the staple food. The rice was planted in small patches in the coulee or slough bottoms. These low lands were generally dry in the early spring, at which time they were plowed and the rice sown broadcast and harrowed in with a wooden tooth harrow. Oxen furnished the motive power.

If the season chanced to be wet, the rice was sprouted and planted in the mud. The field was leveed with a small embankment, and the crop was irrigated by the natural rainfall. If the

season was dry little rice was raised. The annual rainfall of over fifty inches was, however, usually sufficient and rice seldom failed to produce some sort of a crop. This method of irrigation was called "Providence."

The rice was harvested in October with a reaping hook, carried out on high land and shocked; when cured, it was placed in stacks and threshed with a flail or "tramped" out as required during the year. Each day or week the supply of rice for the family was milled or husked by beating it in a mortar with a wooden pestle. The mortar was made by setting a section of a gum log on end and burning or chiseling a hollow in the top. The grinding of the rough husks soon made the mortar clean and smooth. The rice when hulled was winnowed clean; was then ready for cooking with meat or game. In this way the full food value of the rice was conserved as none of the



A reliable means of supplying water for rice growing

outer cuticle or the germ end, which contains the greater part of the protein and fat, was removed. Unpolished rice is much superior to the milled article, consequently much of the rice consumed in the rice belt is husked in the country mill. Native rice, wild duck, *gumbo-fille*, and *Jambalyia* prepared by a Creole chef are dishes that will appeal to the epicure.

Immigration to the Rice Districts—In the late '80s, Northern people commenced to settle in this section, purchasing land from the state and federal governments. They brought with them the modern tools of Northern agriculture. It was found, however, that the natural drainage was not sufficient, and that the wild prairie soils were not at that time adapted to the high land crops of the West, and that rice was the logical crop. This they planted in the low lands of the coulees and flats, and endeavored to adapt labor-saving machines to the exigency of the situation, depending upon "Providence" to furnish the necessary water. But the rainfall could not be depended upon

during all seasons to furnish sufficient water to produce rice except upon small irregular areas, and the labor of working in the mud of such low areas was very great. For about five years, or up to 1895, the existence of the rice farmer was a precarious one. In desperation he decided to pump the water from the streams into canals made by throwing up two embankments from 50 to 100 feet apart, taking the dirt from the middle and thus carrying the water above the surface of the ground so that it could be let out through flumes into the fields or laterals. These canals were a complete success. Of water there was an abundance, and it was only necessary to lift it from ten to thirty feet from the stream into the canals in which it could be carried for as much as twenty miles at a height of from two and one-half to six feet above the surface of the land to be irrigated. Rice could be irrigated at a cost of from $3 to $6 per acre, and with irrigation, the crop was absolutely certain. The virgin soils which represented a deposit 1,800 feet deep with from six inches to three or four feet of black surface soil, would produce from sixteen to twenty barrels (of 162 lbs.) of rice, worth from three to four dollars per barrel.

There ensued a development in Louisiana and Texas comparable only to that of the irrigated districts of California. Within seven years from the completion of the first canals, almost every foot of land, that could be irrigated, was under cultivation for rice. Roads were built, drains were opened, railroads came, towns and rice mills were built, and land values jumped from $1.25 to $40 and $60 per acre. The production of rice in this section increased from a few thousand to 6,000,000 barrels per year. Canals were extended so that the entire country is now under irrigation.

Early in the development of the rice industry it was found that there is an inexhaustible supply of underground water. At a depth of from 225 to 300 feet is a stratum of water-bearing gravel from forty to seventy-five feet in thickness. When this is tapped by a 12-inch pipe fitted with proper screen, the water rises to a point varying from twenty feet below the surface to above the ground, depending upon the location in distance from the coast. When pumped with a centrifugal pump a 12-inch well will irrigate from 250 to 300 acres of rice. The oil wells of this section furnish an abundance of fuel oil for the irrigation pumping plants.

Varieties of Rice—There are a very large number of varieties of rice, differing in shape and color of the grain, in the time required to mature and in the relative proportions of food nutrients—carbohydrates, protein and fat. There are probably more than 2,000 distinct varieties of rice. The three principal varieties or types grown in the United States are the Carolina Gold, the Honduras, and the Japan.

Where rice fields stretch away to meet the sky

The Carolina Gold rice is large of grain, very hard and flinty, and the outer husk is golden-yellow in color, hence its name. The grain does not shatter from the straw easily during storms which are so prevalent on the Atlantic coast. It has superseded all other varieties in the Carolinas, but it does not seem to enjoy the same degree of popularity in the rice belt of Louisiana and Texas—in fact in the latter section it is but little grown.

Honduras rice which takes its name from the country where it originated, requires less time to mature than the Japanese varieties. The straw is tall, the grain is white, both as to husk and kernel, and is much longer and smaller than the Japan. The straw is considerable heavier than Japan straw. Honduras rice does not contain as much gluten as the Japan, consequently it is dryer when cooked and more flakey, and the grains maintain their identity better. Honduras commands a better price, but the yield per acre of head rice, or first quality milled rice, is not so large as that of the Japanese varieties.

Japanese rice is of several varieties, the general characteristics being short straw, a short, thick kernel, and a thin hull; the percentage of bran and polish, the by-products of rice milling, is not so high as in the Honduras. The grain ripens when the straw is still green, and as the latter is short there is little danger of loss of crop by storms. The yield of head rice in the mill and the yield per acre of the rough is greater than in the case of the Honduras, but the market price per pound is generally lower. Japan and Honduras seem to be equally popular in the rice belt; the one matures late and the other early, so that both lend themselves to the requirements of the rice farmer.

Cultivation of Rice—Rice cultivation differs but little from the cultivation of wheat in the West. The soil is alluvial and does not become boggy when wet. A self-binder with lugs on the bullwheel will do good work in six inches of water. Very little if any work of planting or harvesting is done on wet land.

The land is usually plowed with the 12-inch double, or with the triple gang. The steam and gasoline tractor, especially the latter, are coming into use in rice cultivation. Four horses or mules are used on the double gang. Land should be plowed as deeply as possible because the rice roots, even in clay land, penetrate to a depth of fourteen inches. Five or six inches is the average depth plowed. Deepening the soil should be done gradually by plowing from a half inch to one and a half inches deeper each season. Where it is possible, plowing for rice should be done in the fall as soon as the crop is harvested. In this way the red rice (a weed) will germinate, and the land will be exposed

to the air and rains — there is no danger of soil washing on the level prairies of the rice belt.

Fall Plowing eliminates much work in the spring and insures a better crop. It is a common practice to double disk, double harrow, "float," or roll the plowed land, after which the seed is planted with the press drill in 8-inch rows. Many different drills have been tested, but the most popular is the shoe-runner drill with large press wheels. The disk drill cannot be said to be a good implement for all conditions of the rice soils. Rice may be planted in this section from the middle of March to the 20th of June. After drilling, if the land is very dry, it is a good plan to harrow lightly. When the rice comes up, the application of the one-horse weeder will destroy the germinating crab-grass and weeds and be a benefit to the rice.

A rice field in Louisiana

Applying the Water—After the rice plant is out of the ground and has developed two leaves it requires more than eight inches of water to destroy it, but strange as it may seem, too much rain will work more injury to a germinating rice crop than it will to oats at the same state of development. Water is not applied, however, until the plant is large enough to, in a measure, shade the ground. This, however, depends upon the rainfall; if it is very dry so that the rice does not grow, it is well to flood and allow the water to drain off at once.

Rice that has not been irrigated will stand as much or more drouth than oats; and if the land is reasonably moist, it will make a good growth up to heading time; when coming into head, however, it is necessary, in order to insure a good crop, to cover the land with water. Water is used throughout the growing season because it makes the rice grow faster and keeps down the weeds and grass.

Where rice and help are abundant

The fields of this section range in size from three to twenty acres; the average size is about ten acres. An embankment or levee is made around the field. The size of the area within the levee depends upon the contour of the land. The levees are so constructed that when the field is irrigated, the lowest part will have not more than eight inches and the highest part of the field less than two inches of water. The lateral from the main canal is run on the highest part of the farm, following a ridge if there be one. The fields or cuts are laid out adjacent to the lateral.

If the weather is very dry it is good practice to flood the fields along the lateral all the levees will hold. Do this rapidly—twelve hours' pumping is usually sufficient—then turn the water out of the flooded fields down onto the fields below and so into the next until all are wet. The remaining water is turned into the drains. In this way the full value of the water is obtained with as little waste as possible. The rice will grow rapidly and commence to stool or sucker. When it becomes dry again, irrigate as before. Rice fields having once been flooded should not be allowed to become dry enough for the ground to crack or injury will result. When the plants have stooled enough to shade the ground the harvest flow should be put on, or the crop should be flooded and the water maintained until the rice is headed in the fall. The water should be drained off when the rice heads commence to turn down. This, however, depends upon the season. The water is usually turned off from two to three weeks before the crop is ripe, in order to allow the land to become dry before harvest. The harvest in the rice belt commences late in August for the Honduras; the Japan is seldom all cut before the middle of November.

The levees are built with the plow, the grading machine or a V-shaped implement called a "pusher" which is constructed on the farm. The work on the rice farm during the summer months consists in distributing water and watching the levees for leaks.

Harvesting the Crop—The rice crop is harvested with the self-binder. This is similar to the wheat machine, but is very much heavier in construction. The wheels are boxed in with galvanized iron to keep out the mud. The bullwheel is fitted with pointed lugs so that the machine will operate in mud and water should the season be wet, or the drainage bad. The Champion, Deering, McCormick, Osborne, and Plano binders have been used for rice harvesting, but at the present time the Deering and McCormick are used almost exclusively. The writer has used a Deering binder in the early days of rice culture, when six yoke of oxen were required to pull it, and many times the water was over the platform canvas. At the present time six horses are required on a six-foot binder. The gasoline

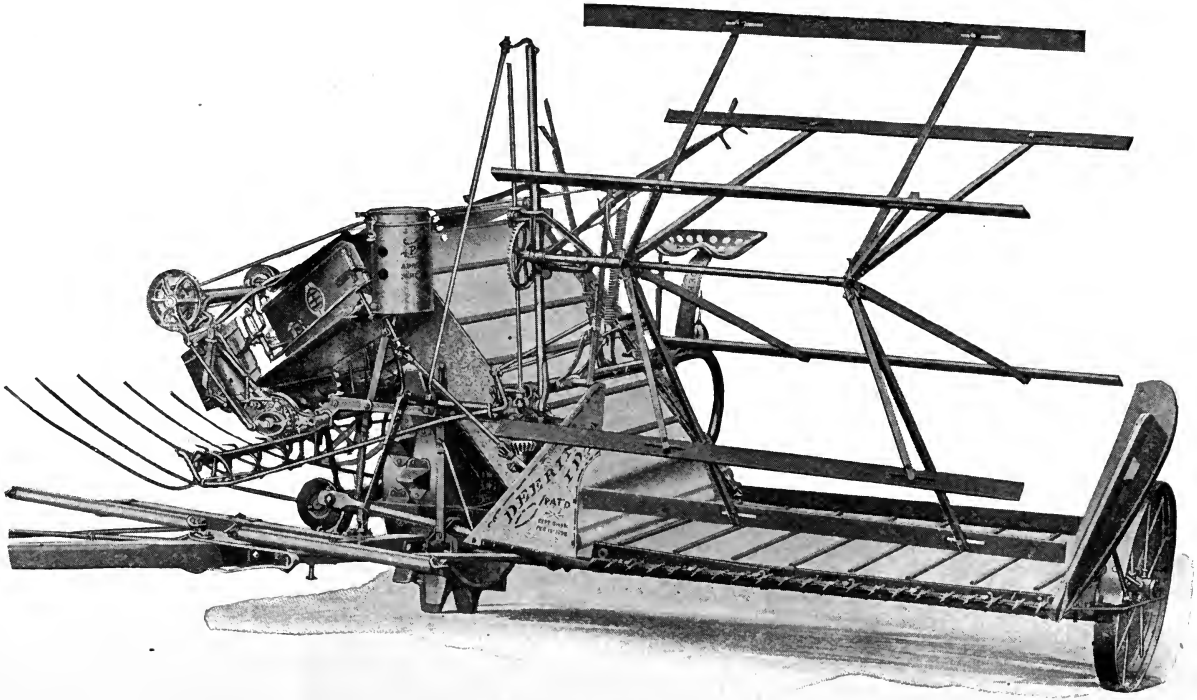
engine is being used with success to furnish motive power and the machine is hauled by three horses. Rice is much heavier and harder to cut than any other grain, largely for the reason that the straw is usually green. A binder will average from six to twelve acres per day. The rice is shocked as soon as cut. In ordinary weather, the rice is dry enough to thresh within three weeks after cutting.

Threshing—The rice thresher is similar to the wheat machine. Like the harvester, it is built stronger and with a few minor changes to adapt it to rice. The threshing is done in the field. The machine is equipped with bagger, self-feeder,

Storing sacked rice

and straw blower. Two thousand bushels per day is not an uncommon run. Rice is put in bags that will hold about 200 pounds and is hauled to the mill or warehouse. If the season is unusually wet, the rice is stacked, but this does not often occur.

Milling—Before rice can be eaten, the outer husk must be removed. This as well as the polishing is done in the rice mills. The polishing process removes the cuticle that covers the grain, and the germ end. The by-products of the rice mills are rice polish bran, and broken or brewer's rice. The reason for polishing is to improve the looks of the sample. It is said also that polished rice keeps better. The greater part of the oil and protein is in the by-products. These are sold largely for feed,



A modern rice binder

although some polish is manufactured into vegetable ivory used in buttons and other articles. The polish sells for about $20 and the bran for $15 per ton. Rice polish makes a splendid stock feed, especially for young animals; in this respect it will compare favorably with wheat bran. The bran is a good feed if used fresh, or if it is heated to the temperature of live steam as soon as it is made. Unless this is done, the oils break down rapidly into the corresponding fatty acids, which impairs the digestibility of the feed. This decomposition is due to an enzyme called *lipase*, which does not develop when the material is heated.

The History of Rice Growing in the South—Its history is similar to that of wheat growing in the West, or the crop industry of any other country where one crop is peculiarly adapted to the soil and climate. Rice is profitable, and it is a crop that is reasonably certain when the irrigation water can be controlled. As a consequence, rice has been grown year after year on the same land without any effort to keep up the fertility of the soil. As a consequence yields per acre were reduced and it became necessary to practice some crop rotation in order to build up the soil and permit the land to rest. More attention is being given to livestock and to the utilization of farm manures. Drains are being opened and the land prepared for corn, sorghum, peas, potatoes, and other crops. Oats are planted in June and turned under for green manure or pastured down in the fall. Rice or corn follows the peas. Commercial fertilizer is being used in considerable quantities in this section.

The soils of the rice belt contain an abundance of potash, but are very deficient in phosphorus; the latter, however, can be cheaply supplied in the form of raw rock phosphate. This, however, can be used only in connection with decaying vegetable matter. It should be applied at the rate of 1,000 pounds per acre once every four years. Turning under cowpeas or other legumes will maintain the nitrogen in the soil and render the phosphate of the raw rock available as well as the soil potash, which is in a more or less fixed condition due to continual cropping to rice.

The Care and Protection of Farm Equipment

By M. R. D. Owings
Advertising Manager, International Harvester Company of America

Since the arrival of dollar wheat, seventy-five cent corn, and fifty cent oats, editors, college professors, and economists have taken a great deal of pleasure in speaking of the present day farmer as a "business man." They do not always define the term and on close scrutiny it looks as if the so-called "business" farmer is such sometimes largely because high prices of his products have made him prosperous, rather than because of his adoption of more business-like methods

It has been well demonstrated that a real business man is successful as a manufacturer in so far as he is able to make mechanical labor take the place of less productive hand labor, and that a real business man as a farmer is similarly successful in so far as he can do the same thing.

But here, very often, is where the resemblance ceases.

The manufacturer invests so much money in labor-saving machines, he allows so much for depreciation; and then proceeds to see that his machines are well housed, well cared for, and kept going. He figures that they must pay so much interest on the original investment plus a profit sufficiently large to equal, ultimately, the original investment. The longer the machines can fulfill the duties for which they were intended, the greater the money returns on the first outlay.

When a farmer figures on the same basis in caring for his equipment, the economic term of "business man" fits him, and generally you can call him an automobile owner as well. But when he invests his capital in expensive machines—and many of them—such as a modern farm nowadays necessitates, and then leaves his plow in the fence corner, his binder in the field, and his new wagon under the eaves of his cow shed, he falls short of exercising the right kind of business methods.

Perhaps he makes enough to be able to do all this without noticing the drain upon his gross income. Some farmers figure that way, but it is not good commercial doctrine.

The money which a farmer puts into a binder, mower, or manure spreader, is capital invested just as much as the money another man puts into a machine for making shoes or spinning cotton. It deserves an annual interest and an ultimate profit equally as much, and it is entitled to as thorough care and protection. Furthermore, the laws governing continuity of service apply exactly the same to a cream separator and a wagon as to a planer or grinder. Of course, owing to the seasonable use of farm machines, there are lapses of time when certain machines must remain idle. It is at this period that they should be best protected. Scientists say that the muscles of an arm wither more quickly from inactivity than from over-activity. The same thing is true of equipment, whether on the farm or in the factory. More plows have been worn away by the weather than were ever worn away by service.

True as this is, very little attention has been paid to the science of machine care. Experimental stations will work for years to show how to grow forty bushels of wheat where only thirty bushels grew before. No one questions the usefulness of this work, but it takes the difference of a good many acres to pile up enough dollars to buy a new binder; and yet, very little time is spent in showing how to increase the life of a binder from five to ten years. Perhaps they leave it to the common sense of the farmer. If they do, all right, for common sense is really the thing that is needed.

College instruction, ancestral advice, and original research in the care of farm machines can all be simmered down to these three elementary necessities — good roofs, good paint, and good lubricants. These three determine whether the days of a machine shall be long in the land or whether it shall soon return to the dust whence it came and another order go to the firm who made it.

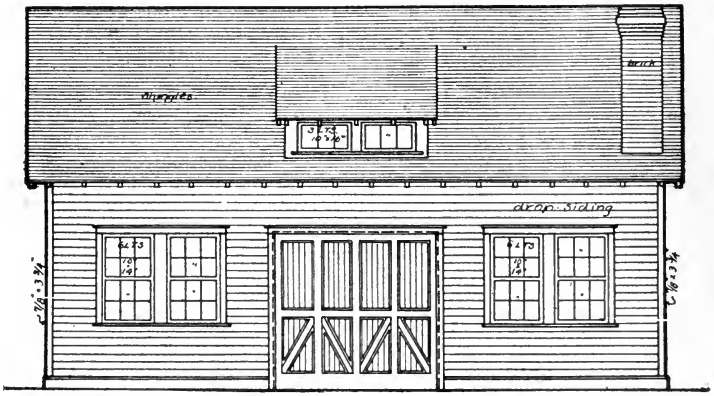
Let every farmer attend to this trio. How and when are questions which each must answer for himself — not very profound questions, but very important.

Few people realize how simple and yet how essential such care is, and for those who have overlooked this phase of agricultural life, we give the experience of one successful Kentucky farmer which may contain helpful suggestions.

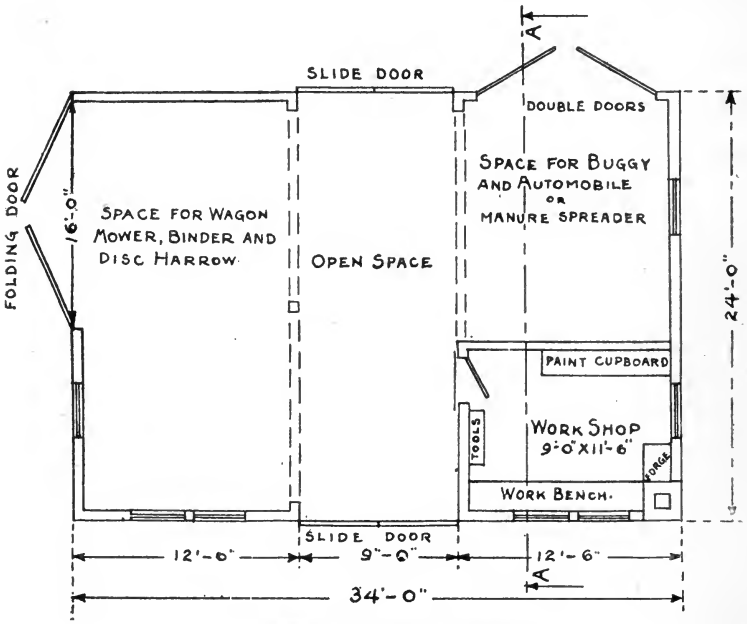
This man ran a big farm in that state and in spite of inefficient help and long-used soil, made money. He was a firm believer in the above mentioned triumvirate — good roofs, good paint, and good lubricants — and he practiced what he believed. Back of his barn he had erected a long, low shed, not particularly showy nor expensive, but dry, and under this shed he kept everything in the equipment line — from grindstone to wagons. In one end he built a home-made improvised paint shop. Although his reputation as a family man in that country was

good, it is said of him that he would just as soon leave a member of his family outside all winter as his mower or his drill.

When he finished his plowing, he saw to it that his men



Front elevation of farm machine shed

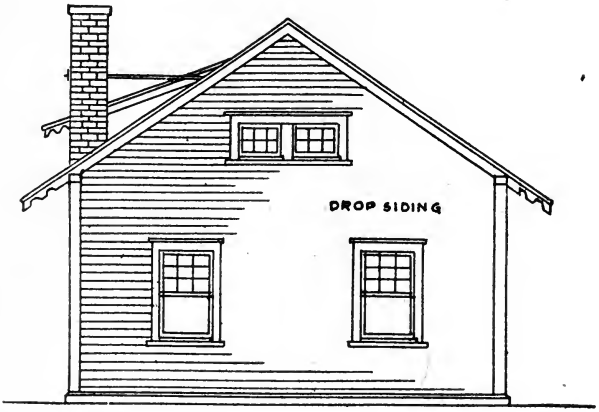


Floor plan for machine shed

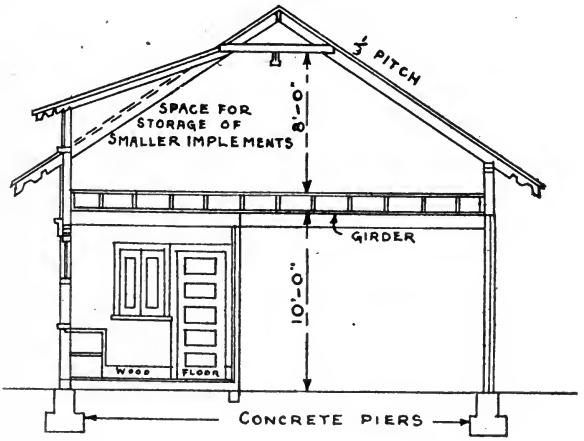
brought the plow back to the shed. He then went over it thoroughly with a coat of grease, and it was left that way all winter. In the spring a little kerosene was applied which

loosened the grease so that with the first contact with the ground the share came out smooth and shiny like a mirror.

"That plow," said the Kentuckian, "cost me $35.00. The grease cost but a few cents, and it made the plow last several years longer.



End elevation



SECTION ON LINE A-A
SCALE 1/8" = 1 FOOT

"That is just an illustration," continued he, "of my procedure with every machine I own. Every two years I make it a point to go over the binders, mowers, and all the machines I have on the place with a good metal base paint. I take off the binder canvases, roll them up, and put them out of the way of

the mice. I grease the sickles of the mowers and binders, wrap them up, and put them away in a dry place. Then when I have occasion to use these machines I put the sickles back in place, and before the first circuit of the field is completed they are as bright and shiny as when new.

"Perhaps also the question of pride helps a little, because I always like to have everything about the farm clean and bright. I generally use red paint because I like that color, and because red lead is better than white lead for outside work. I keep even the tongues and whiffletrees of my wagons as good as new. They are mostly made of locust in our country, and when properly painted, last a century.

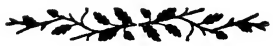
"This painting is not just a hobby; I have found that it pays. One time I sold a binder which I had used steadily for six years, for over two-thirds of what it cost me, and I didn't cheat the fellow, either. It was practically as good as new.

"I am a paint advocate alright, and it seems to me that hired men may come and hired men may go, but my wagons, mowers, and drills go on forever.

"I don't use up all this paint because I feel more friendly toward the paint manufacturers than I do toward the International Harvester Company of America. It is merely a matter of economy with me because paint is cheaper than new machines.

"I am even more cranky on the lubricants. You know the parts of a binder, for instance, that are subject to wear are the chains, the gears, the boxes, and knotter. Painting won't help these, but plenty of oil will. When I first started farming the most important bit of barn furniture was the oil can. I make it a rule, after each long trip, to grease my wagons, with the result that they are always ready and always ship-shape. I invent patent dust protectors of my own when none come with a machine, and where this is not possible I keep the exposed parts well cleaned.

"Now all of this may seem rather unimportant to some farmers, or they may think it a great deal of trouble for nothing, but I never notice the trouble and, in the long run, I find that it is a good form of economy. I farmed for many years, at a time when prices were much lower than they are now, and I made my farm pay. I do not claim that it was all due to my caring for my equipment, but the fact that I have made every cent of capital invested in machines return 100 cents on the dollar, and then some, has had a great deal to do with my prosperity."



Tile Drainage in the South

By J. E. Waggoner

Agricultural Extension Department, International Harvester Company, Harvester Building, Chicago

The vast area of undrained swamp lands in the South, if properly tiled and cultivated, would add millions of dollars to our wealth, thus increasing the comfort of our homes and aiding in the development of our industries. It is true that a large proportion of this land is located in large drainage districts requiring considerable capital to develop properly. It is not the purpose of this article, however, to deal with large drainage districts, but rather to consider the small 40, 60, 80, and 160-acre farms which have land that should be drained.

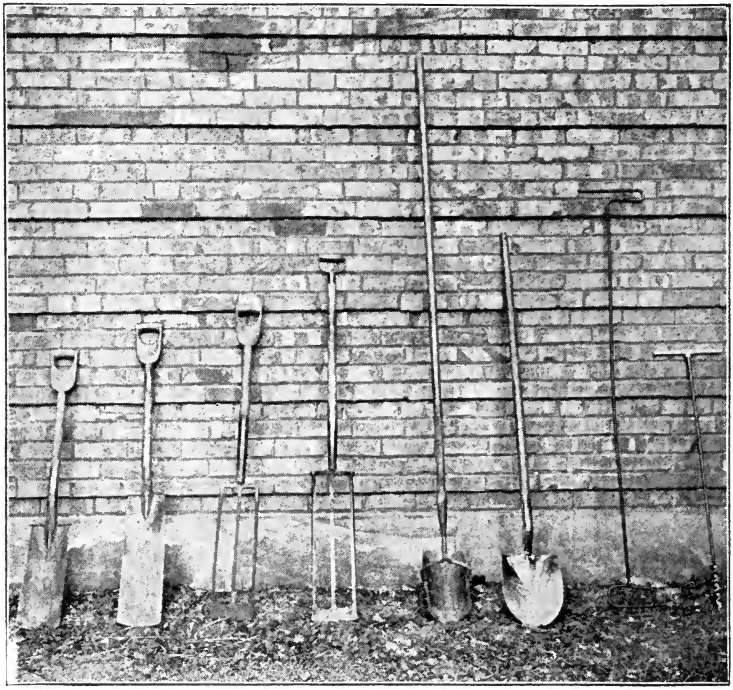
Thousands of farmers are attempting to farm land that is only partly drained. Many of the total failures of crops, as well as a large percentage of partial failures, are due to attempting to farm land which is in poor condition, due to a lack of drainage. Cold soil, slow to warm up in the spring, a hard, packed condition during the hot summer, and poor, stunted, yellow-looking plants are indicative of undrained land. The soil is the home of the plant, which unlike other forms of life is unable to change its location. If a seed falls in a low place it must germinate and grow there if at all. If the soil is in good condition, all is well and good. If it is partly drained or not at all, the plant's lot is a poor one. Tile drainage is one of the most important and one of the most valuable ways of improving the condition of the soil—the home of the plant.

The water of the soil may be divided into two classes, drainage water and soil moisture. The drainage water is that which may be removed by gravity, or, in other words, that water which fills the spaces of the soil. Soil moisture is made up of the small films of water which encircle each particle of soil. It is the soil moisture which is utilized by the growing plant. Soil moisture is replenished from the drainage water, but the latter is not utilized directly by the growing plants.

Tile Drained Land Warms Up Early—Well drained land will warm up from ten days to two weeks earlier in the spring, thus permitting earlier and more timely cultivation. In the

production of early crops, two weeks' gain at this season often means the difference between a bumper crop and a poor one.

Tile drainage raises the temperature of the soil by removing drainage water which otherwise would have to be evaporated from the surface. Ordinary clay soil contains from 40 to 65 per cent of voids or air spaces; black loam, 40 to 50 per cent; and sandy loam, 35 to 40 per cent. If the soil is saturated with water, these voids are full. Then in a saturated cubic foot of clay soil there would be practically 50 per cent water or at least thirty pounds of water. The same would be true in relative



Tools used in tiling

proportions with the other types of soil. It has been found by experiment that removing one pound of water by evaporation lowers the temperature of the soil 10.3 degrees. It is easy to see that where the soil is saturated the temperature would remain low considerably longer than if the drainage water were removed by tiling or underdrainage instead of by evaporation.

Facilitates Aeration—Air plays an important part in crop production. In fact, many soils have been found to be practically unproductive until properly aerated. The presence of air encourages the roots to penetrate into the subsoil, through

which the air circulates still further, encouraging and supporting bacterial growth, which is absolutely necessary in order to convert vegetable matter and humus of the soil into available plant food. The combining of the elements and gases of the air with soil moisture creates conditions which encourage chemical action, thus liberating many plant food elements from the insoluble and inert particles of soil.

Tile drainage in reality establishes what might be termed a

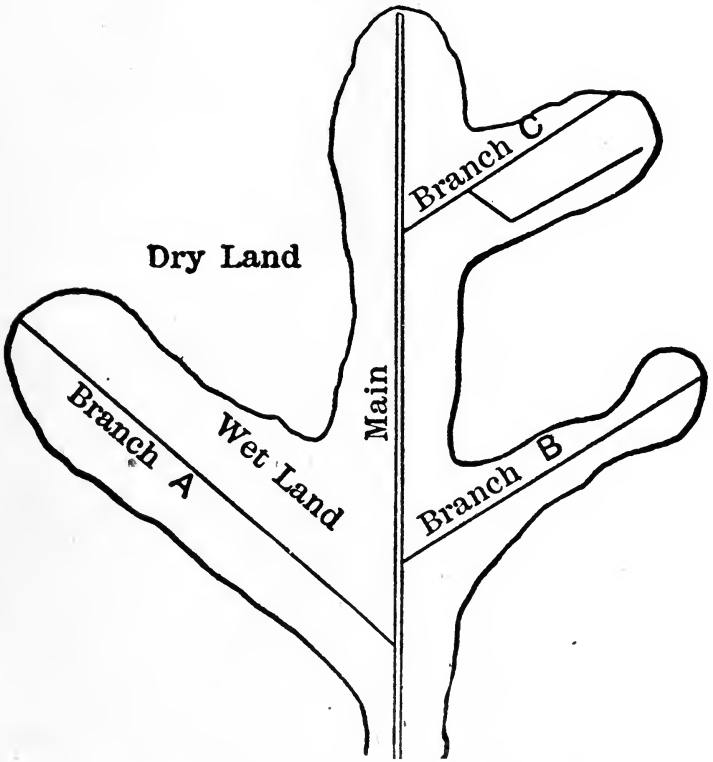


*Fig. 1. The natural system

reservoir, which offsets the effect of the unusually heavy rains by permitting the water to soak into the soil instead of running off the surface. As this water finds its way down through the soil to the tile drain below it carries with it the gases of the air, thus tending to deepen the soil and to improve it as the home of the plant.

Reduces Erosion and Improves the Soil—In sections where the rainfall is unusually heavy, one of the problems is to prevent soil erosion, or the wasting away of the surface by

washing. Tile drainage deepens the soil, allowing it to take up some of the water, and thus tends to prevent surface erosion.

It is a matter of observation that well-drained land will resist drought better than undrained. The principal reason for this is the improved physical condition of the soil resulting from drainage. The drained soil will also withstand wet weather much better than undrained.

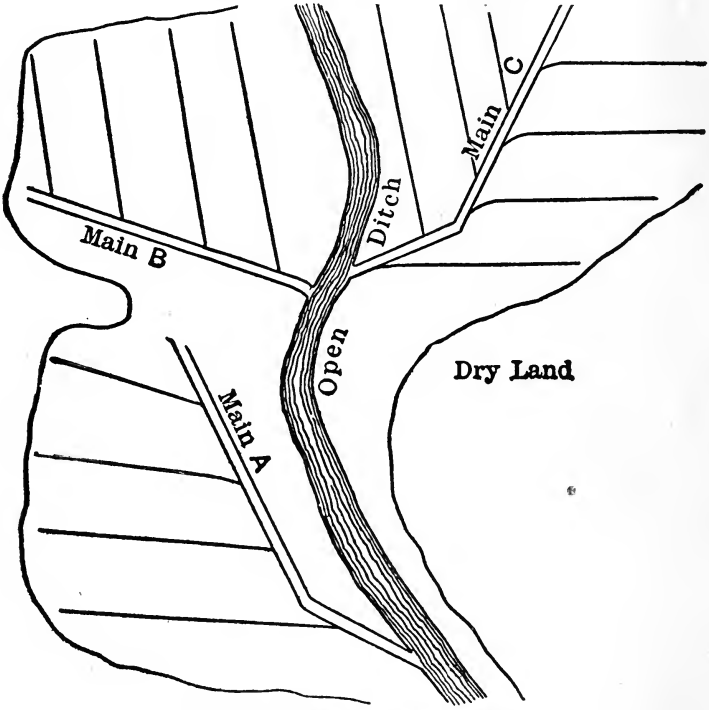


*Fig. 2. The grouping system

Principles to Follow in Tile Drainage—1. Lay the drains in the natural lines of drainage as much as possible, as laying them in this way will tend to increase the efficiency of the drain. 2. Avoid short laterals so far as possible—the land near the main line is drained by this line, and if short laterals are used a part of the land will be double drained, thus increasing the expense unnecessarily. 3. Lay the tile lines as straight as possible, as crooked lines retard the flow of the water. Where the direction of the tile is to be changed use an easy curve. 4. Lay the tile lines so as to reach all parts of the field.

Systems of Tile Drains—Keeping in mind the principles to follow as outlined above, there are at least three systems which may be used for laying out tile drains.

The simplest system is indicated in Figure 1. There is a main line with laterals wherever occasion requires. This system may be used in small fields, and on small undrained areas.

The grouping system, as shown in Figure 2, is a combination of several natural or simple systems, and may be used where the area is quite large, in basins, sloughs, and elsewhere if a good outlet is available. By a natural system is meant one that follows the direction that the water takes when running off the surface.

The gridiron system, as shown in Figure 3, is sometimes adapted to land that is nearly level, and is made up of a series

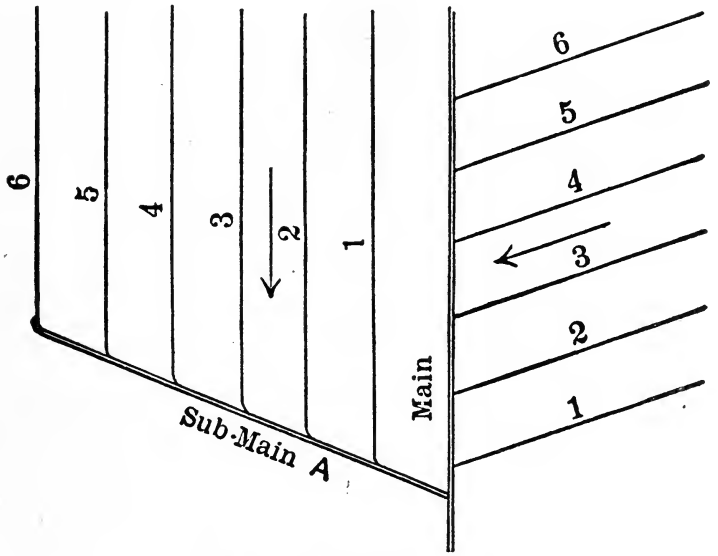


*Fig. 3. The gridiron system

of parallel laterals, each emptying into the same main line.

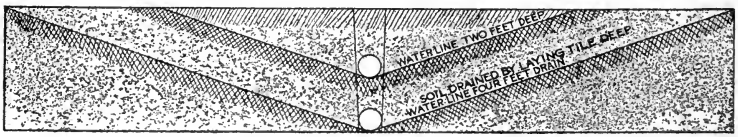
Each of these systems embodies the use of the four principles as outlined above; namely, following the natural lines of drainage, avoiding the use of short laterals, following straight lines, and reaching all parts of the field.

Depth of Tile—The depth at which tile should be laid varies considerably in different soils. In the prairie land of some sections subject to periodical freezing, and where the soil is of an alluvial nature, the tile line may be laid four to four and a half feet, and yet give good results. In soils that are waxy, impervious, and of a fine texture—of a buck shot nature—the tile should not be laid so deep. Generally speaking, the best success has been obtained in most Southern soils by laying the

tile from thirty to thirty-two inches deep. It is never advisable to allow tile to be less than eighteen inches below the surface.

Distance Between Tile Lines—The distance between the lines of tile varies with the depth that the tile is laid, which is determined by the nature of the soil. When the tile are placed shallow, the lines must be put close together and vice versa. The distance apart varies from thirty-five to 180 feet. Experience will teach what is best in individual cases.

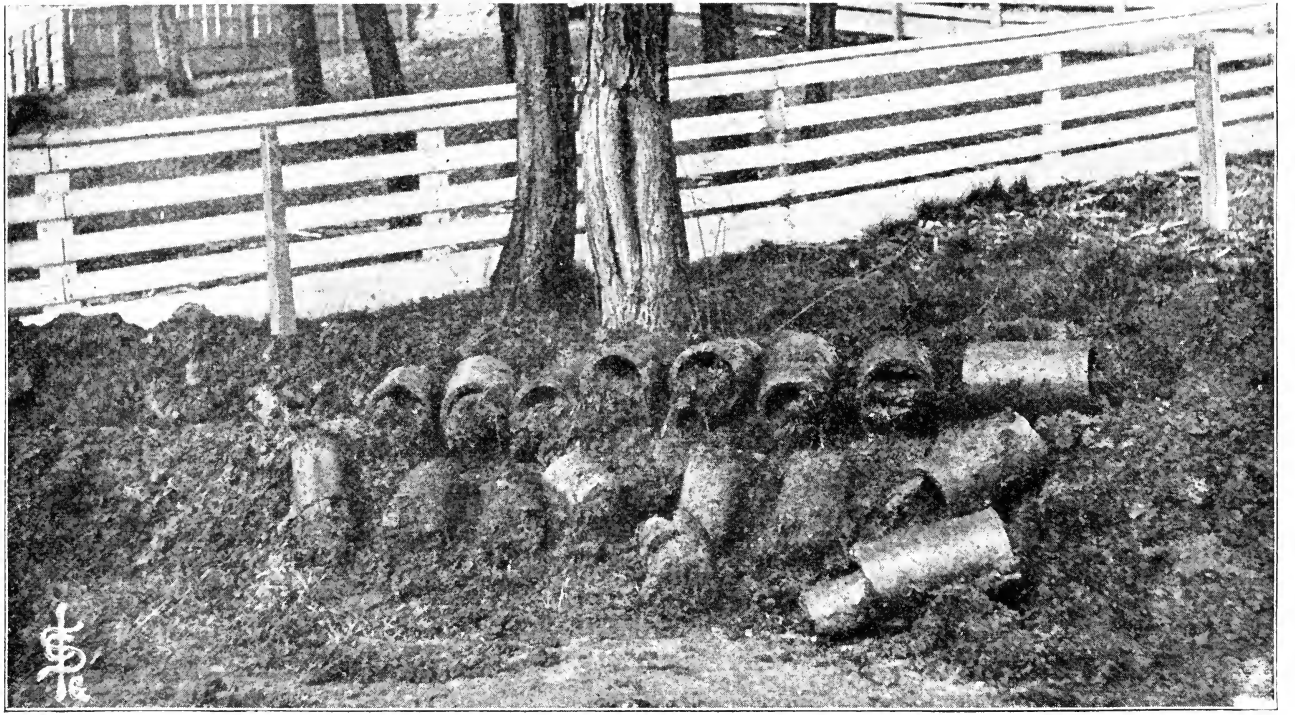
The Grade to Use—By the grade we mean the fall per hundred feet. This is often expressed in feet, but may be expressed satisfactorily in inches. Generally speaking the size of the tile should be increased with the lessening of the grade. We have seen a case where the tile lines were laid perfectly level for several hundred feet, and gave good satisfaction, but in this case, the required velocity of the water was gotten by the excess



The depth of the tile effects the width of area drained

of fall from the laterals and from the main line above. Also, in this particular instance, the tile was sixteen inches in diameter. Smaller tile would probably not have given good results. A fall of two to four inches per hundred feet will give good results with tile from four inches and up, providing the tile line does not exceed 800 or 1,000 feet in length. For shorter lines, less grade may be used, and in case of longer lines, larger size tile should be used. Remember you can never get too much grade.

Selecting the Tile—In purchasing tile it is well to see to it that they are vitrified but not glazed. The ends should be squarely cut, and it is extremely important that the inside should be smooth and free from roughness. Table 1 shows the size of tile used for different areas of land when the fall is known. For instance, if we have one foot fall in one hundred feet, four-inch tile will drain 11.9 acres, six-inch tile will drain 33.1 acres, etc. This will assist you in selecting the size of tile to use.



These tile were filled by the roots from a willow tree

SIZE OF TILE FOR MAIN DRAIN

Table 1. (McConnell)

FALL	ACRES DRAINED				
	4-inch Tile	6-inch Tile	8-inch Tile	10-inch Tile	12-inch Tile
1 foot in 20	26.8	74.4	150.0	270.0	426.0
1 " " 30	21.8	60.4	128.0	220.8	346.0
1 " " 40	18.6	51.6	108.8	189.6	298.4
1 " " 50	17.0	47.7	98.0	170.4	269.0
1 " " 60	15.6	43.4	90.0	156.0	246.0
1 " " 70	14.5	39.9	83.0	144.4	228.1
1 " " 80	13.4	37.2	77.0	135.0	213.0
1 " " 90	12.6	35.0	72.5	127.0	200.5
1 " " 100	11.9	33.1	69.2	120.6	190.5
1 " " 150	9.5	26.6	56.0	97.3	154.4
1 " " 200	8.2	22.8	48.0	83.9	132.5
1 " " 250	7.5	20.4	42.4	74.4	117.0
1 " " 300	6.9	18.4	38.2	65.5	107.0
1 " " 400	5.9	16.5	32.6	60.3	90.7
1 " " 500	5.2	14.8	30.1	54.0	81.6
1 " " 600	4.7	13.3	28.0	48.6	74.0
1 " " 800	4.1	11.4	24.0	41.9	65.0
1 " " 1,000	3.7	10.2	21.2	37.2	56.0

Cement tile may be used equally as well as clay tile, if they are available. Properly made cement tile are being generally used, and are giving good satisfaction. In cases where a large area is to be drained, and sand and cement can be obtained cheaply, a machine for making cement tile may prove more economical than buying the clay tile.

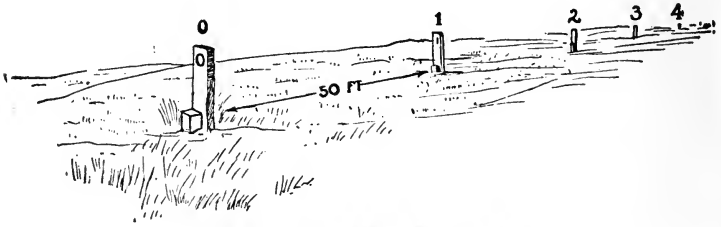


Fig. 4. The stakes and hubs

Laying Out a System of Tile Drains—The first thing to do is to locate the outlet, which should be a good one. Starting at the outlet, stake out the main line, as shown in Figure 4, from which the laterals may lead to all parts of the field. The hub stakes should be set fifty feet apart, and a foot to one side

of where you intend to dig the ditch, by the side of which is driven a guide stake which should stand about a foot high, and should be labeled or numbered beginning at the outlet.

Finding the Grade—There is very little complicated engineering work connected with laying out a system of tile drains on the ordinary farm land, but when the thousands of dollars that have been wasted through a lack of proper laying of tile are considered, the importance of following some correct method of finding the grade is apparent. If you do not have a farm level, or are not familiar with the handling of this instrument, it would be advisable to employ a competent engineer to lay out

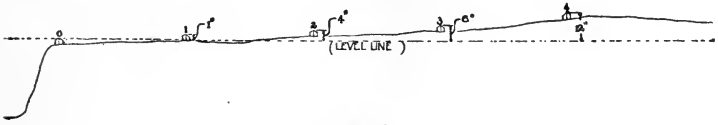
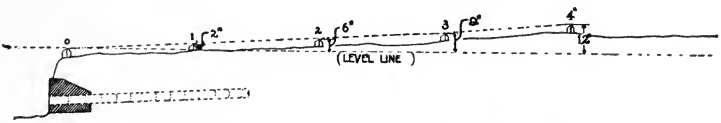


Fig. 5

your tile drainage system. The extra expense of the engineer is a very small percentage of the total cost of the tile drain, so small, in fact, that one cannot afford to risk laying the tile improperly. The method of securing the grade, as outlined below, will assist the farmer who attempts to use a level of his own, and for this reason it is made as simple as possible. Like other methods, it is subject to some error, but if carefully executed, the percentage of error will be small, and it has in its favor the strong point of simplicity.

Starting at the outlet, take the elevation of the hub at that point, which we will call Station 0. We will consider this as



After the final hubs have been set

the datum plane, or in other words, will figure all other elevations from this point. Next get the elevation of Stations 1, 2, 3, 4, etc. As you will note in Figure 5 an example has been worked out giving the different elevations at each point. For instance, the elevation of Station 1 is one inch higher than Station 0, Station 2 is four inches higher, Station 3 six inches higher, and Station 4, twelve inches higher than Station 0. You will note that the distance from Stations 0 to 4 is two hundred feet, giving a fall of three inches every fifty feet. With this in mind we will start at the outlet, and set the final hubs. By the use of a surveying instrument, drive the hubs at the various stations until they are the following distances above the

hub at Station 0: Station 1, three inches; Station 2, six inches; Station 3, nine inches; Station 4, twelve inches. If it were possible to sight over the top of these hubs, we would find that they are in a straight line, and that this line has a uniform slope of six inches to a hundred feet.

All fields may not work out as simply as the above example, so we will cite another case, which will show how to handle a more complicated problem. Figure 6 shows that the elevation of the different stations above Station 0 is as follows: Station 1, one inch; Station 2, four inches; Station 3, six inches; Station 4, eighteen inches. Now, if we were to divide the eighteen inches by four, giving a uniform fall of four and a half inches per fifty

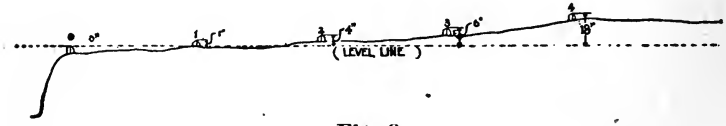
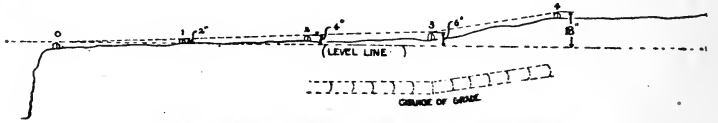


Fig. 6.

feet, by the time we reached Station 3, we would be too close to the surface of the ground with our tile line to obtain profitable returns. In this case, we will consider only Stations 0, 1, 2, and 3. We will divide six, the elevation of Station 3, by three, which will give a uniform fall of two inches per fifty feet. Starting as before, we will drive the hub at Station 1 until it is two inches higher than the one at Station 0, Station 2 will be four inches higher, and Station 3, six inches higher. We will now change the grade, and set the stake at Station 4, twelve inches



The final hub showing change of grade

(the difference between 18 and 6) above the stake at Station 3. This will give the line a fall of twelve inches the last fifty feet.

Grading—The three systems of grading that are generally used are the target, the string, and the flow of water. Of these the target system is the most accurate for all practical purposes and the most generally used, and for this reason will be considered in this article. The string sometimes used is subject to sag and is affected by the wind, thus making it unreliable and not to be generally recommended. In some cases, where the fall is unusually great, the flow of water might be used satisfactorily. It is not to be recommended, however, because of the impossibility of detecting small variations in the grade, which will cause pockets in the tile line. These pockets soon

become filled with silt or sediment, thus decreasing the efficiency of the tile. When the amount of money, time, and labor invested in laying a tile system is taken into account, it is easy to see the importance of being absolutely certain that the tile is laid to grade, and that the grade is properly established. This can be done only by using a surveying instrument.

The Target System—All that is necessary in the target system of grading is to make two or three targets as shown in Figure 7, and one sighting rod, which should be about four and a half feet in length, depending upon the height of the man doing the grading.

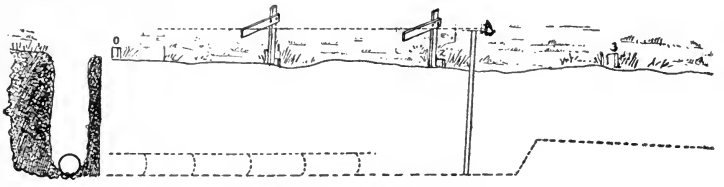


Fig. 7. Grading the ditch

The targets may now be set as follows: We will say that the tile at a certain station are to be laid thirty inches deep. The sighting rod is fifty-four inches long. The target should be set so that it is two feet above the hubs. In other words, the depth of the ditch and the height of the target should equal the length of the sighting rod.

Digging the Ditch—Start at the outlet in digging the ditch. The top twenty-four inches should be removed, leaving the last six inches to be thrown out by the man doing the grading.

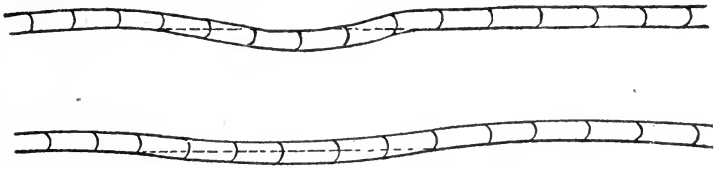


Fig. 8. Sags in tile line soon become filled with silt

Start at the outlet when doing the grading, so that the sighting rod will just reach the top of the target. Work back to Station 1, keeping the top of the sighting rod in line with the top of the two targets. Work this way until you have passed Station 2. Then remove the target at Station 0, and place it at Station 2, setting it the right distance above the hub. Continue until the ditch is finished. By a little practice you will be able to grade a ditch properly, giving it a uniform grade from end to end, which will insure proper laying of the tile, and prevent the loss due to sags and variation in the grade of the tile.

To lay stress upon the danger of poor grading, you will

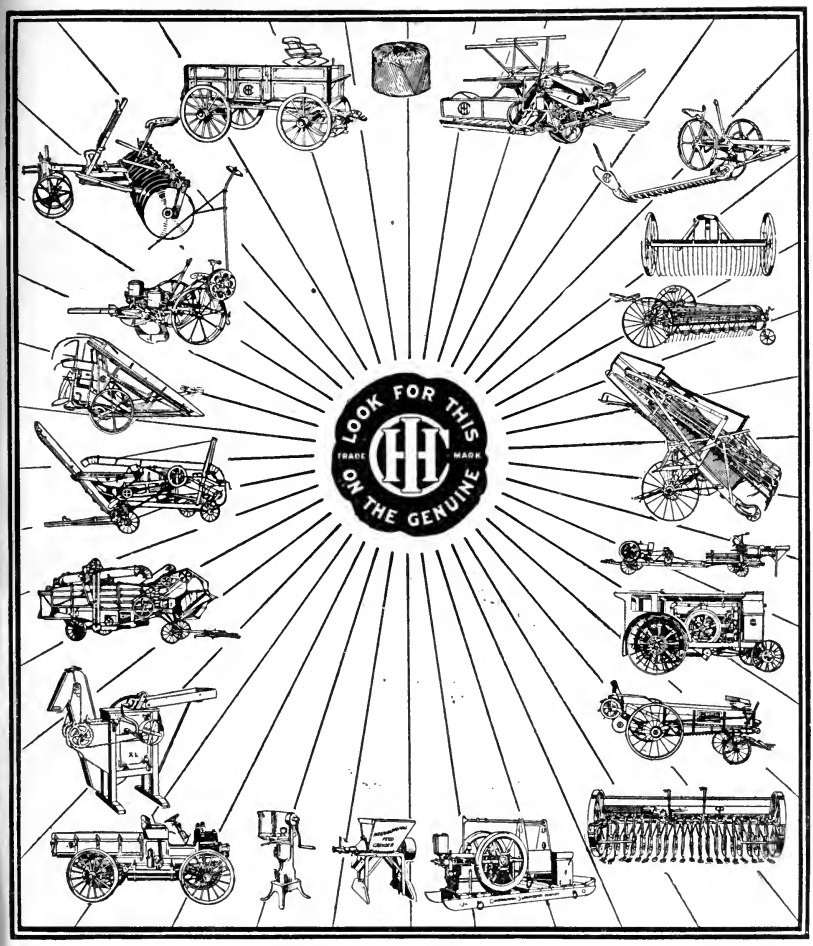
observe in Figure 8, the result of carelessness in grading the ditch. The low places or sags in the tile become filled with dirt until finally the tile is completely choked. This can be avoided by a careful surveying of the land before attempting to drain it and by exercising a little care in establishing the grade line.

Laying the Tile—In laying the tile line, we should begin at the outlet, which should be carefully protected either by building a small concrete outlet protector, or by using one of the galvanized outlets which may be purchased on the market. It is usually best to use a liberal quantity of concrete, putting it around the first five or six tile. This will prevent settling and clogging, providing the outlet is subject to washing. A few iron bars across the opening of the outlet will prevent small animals from entering the tile. The tile should be laid close together—as close as possible. If the cracks between them exceed one-eighth of an inch they should be covered with pieces of broken tile, or with heavy clay, or some other such substance. In sandy soil, it is important to see that the bottom edges of the tile fit closely together. In this type of soil it is best to put a small quantity of heavy clay underneath the joints. This may seem to be an unusual amount of bother and trouble, but when one considers that it is much better to lay the tile properly in the first place, than it is to dig it up after it has become obstructed, he will realize the importance of exercising a little care to begin with. After the tile is laid, a few inches of dirt should be carefully placed on top to hold them in place while filling the ditch.

Filling the Ditch—Filling the ditch may be done by the use of the slip scraper, plow or road grader. The plow is most commonly used, it being necessary to make a long evener so that the horses may walk far enough away from the ditch to prevent any danger of falling in.

Open Ditches—The open ditch finds its best use as an outlet for tile drains. When the volume of water is sufficient to warrant digging an open ditch it is best to use a team and a slip scraper. First, plow several furrows, then by the use of the slip scraper open up the ditch. This will make a shallow ditch, which may be easily crossed and can be kept clean by the use of the mower, except in cases where excess of water causes washing. If such is the case a permanent ditch is needed. An open ditch is generally an eye sore to a field, as it is a place for the growing of noxious weeds. It is inconvenient to cross with a team and prevents the cultivation of all the land. It is much better wherever possible to use a tile drain instead of an open ditch.

*Taken from Elliott's Engineering for Land Drainage.



THE I H C LINE

GRAIN MACHINES

Binders — Headers
Reapers — Header Binders

HAY MACHINES

Mowers — Hay Loaders
Rakes — Hay Presses
Sweep Rakes — Stackers
Tedders — Side Delivery Rakes
Combined Sweep Rakes and Stackers

CORN MACHINES

Planters — Pickers
Cultivators — Shellers
Binders — Corn Stalk Rakes
Huskers and Shredders

TILLAGE

Disk Harrows — Cultivators
Spring-Tooth Harrows
Peg-Tooth Harrows
Combination Harrows

GENERAL LINE

Auto Wagons — Binder Twine — Manure Spreaders
Feed Grinders — Kerosene-Gasoline Tractors — Rope
Cream Separators — Threshers — Knife Grinders
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